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TABLE OF CONTENTS.

Page.

LEADING ARTICLES:
A Small Hydraulic Dam Built by the Roland Park Co., Md. (Illustrated); John H. Walzl 621
The Application of the Reservoir System to the Improvement of the Ohio River; Capt. Wm. D. Connor, U. S. A., with a reply by Mr. Marshall O. Leighton, Assoc. M. Am. Soc. C. E. 621
A Reinforced-Concrete Cold-Storage Building (illustrated); William F. Tubesing 626
Fireproof Building Construction and Concrete Building Construction 627
A Long Span Timber Roof Truss; J. C. Lathrop Assoc. M. Am. Soc. C. E. 628
The Block Signal Train Indicating and Emergency Safety Equipment of the Interborough Rapid Transit Co., in the East River Tunnels, New York City (illustrated) 629
The Effect of the Conservation of Flow in the Ohio Basin on Floods in the Lower Mississippi; A. H. Horton, Assoc. M. Am. Soc. C. E. 631
A Structural Plant in the Philippines (illustrated); Royal J. Mansfield, Assoc. M. Am. Soc. C. E. 633
Test of a Direct-Acting Simplex Boiler-Feed Pump (illustrated) 634
Some Unsolved Problems in Metal Mining 634
A Device to Increase the Effective Head of a Water-Power Plant by Utilizing Waste Water (Illustrated) 635
Alexander Mackenzie (with portrait) 636
William Dana Ewart (with portrait) 636
The Deposition of Arsenic from Smelter Fumes and Consequent Poisoning of Vegetation 636

Page.

An Unusual Building Accident: Foundation Failure During Construction (Illustrated) 641
Notes from Engineering Schools 642
EDITORIAL 637
The Limits of Train Indication for a Block Signal System—The Portage Reservoir for Control of the Genesee River—Dangerous Schools in Large and Small Cities—The Mythical Immunity of Schools from Fire.
The Reservoir System for the Control of the Ohio River 638
LETTERS TO THE EDITOR 639
Method of Running Curves from Paper Location (Illustrated); J. W. Moore—The Removal of Suspended Matters from Water and Sewage, and the Removal of Bacteria from Air for Enumeration (illustrated); C.-E. A. Winslow—Confusion of the Terms "Asphalt" and "Pitch" in Specifications; C. G. Atwater, M. Am. Soc. M. E.—Laying out Turnout Curves (illustrated); Jos. P. White—The Engineering Control of Public Works; C. S. Riché—Diagrams for Finding Economic Thicknesses of Reinforced-Concrete Slabs; R. E. Steinsberg—Compensation of Grades on Curves; Wm. G. Raymond—Compensation of Grades at Stopping Points; Winfield Holbrook, Walter Loring Webb, H. R. Safford—Notes and Queries.
ENGINEERING NEWS OF THE WEEK 642
PERSONALS 644
ENGINEERING SOCIETIES 644
ENGINEERING LITERATURE SUPPLEMENT 645

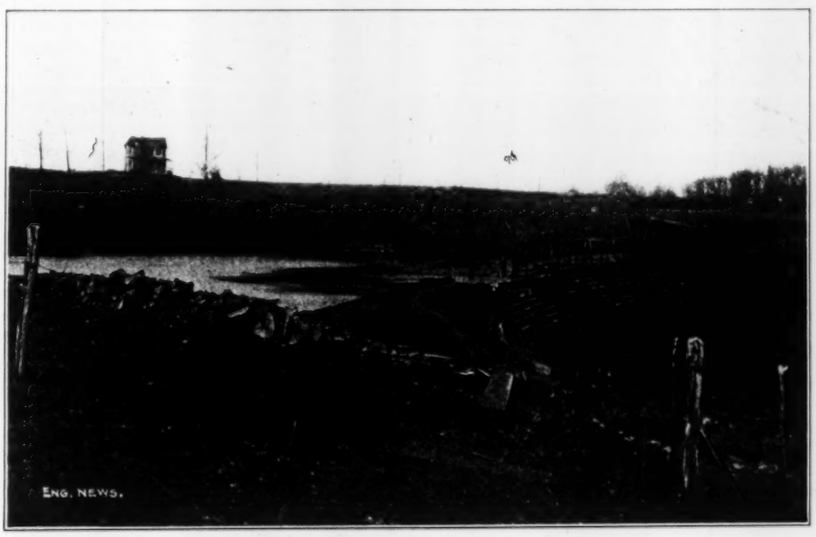
A SMALL HYDRAULIC-FILL DAM BUILT BY THE ROLAND PARK CO., MD.

By JOHN H. WALZL.*

An interesting piece of work is being done by the Roland Park Co., of Baltimore, in connection with its general scheme of hydraulic grading.

A hill to be graded off and a valley filled called for the moving of 50,000 cu. yds. of earth. A dam 24 ft. in height and 400 ft. long was necessary to accomplish the work, and as it would have been an expensive operation to build a sufficient dam with horses and scrapers, it was decided by the writer, who served as engineer for the work, to build the dam by the hydraulic process.

The earth was deposited along the face of the dam by means of flumes and was held in place by the use of 1 × 12-in. boards, 16 ft. long. These boards, set on edge, were held in position by stakes driven into the earth composing the fill. Each tier of boards was set so that they lapped, vertically, the former or lower tier by 2 ins., thus forming a backing for the earth and water to fill against. The stone, gravel, sand and other heavy material remained in the body of the dam, while the lighter material and muddy water flowed into the pond. Here the mud settled and clear water was discharged from the pond, it being very essential that no muddy water be discharged into the adjacent stream.



HYDRAULIC-FILL DAM UNDER CONSTRUCTION FOR THE ROLAND PARK CO., MD.

The dam was built on a slope of 2 to 1, without any trouble, except at one point, where the lower end of the dam had been kept up with wheelbarrows in order that the pond might have a size sufficient to settle the water before discharging it. Here the soft mud accumulated in some quantity. When the flume was brought out to that point and the heavy material deposited on top of the soft, it caused the face of the dam to bulge, as shown in the photograph. No serious trouble resulted. As can be seen, the planking was carried on in the regular way and the bulged place was passed over without repair.

It is to be noted that not a single nail was driven in the construction of the entire dam. When the work is finished the boards and stakes will be removed and the slope sodded. Mr. J. W. Bollman is Chief Engineer of the Roland Park Co. and the writer is engineer in charge of the hydraulic plant.

*Care of the Roland Park Co., Roland Park, Baltimore Co., Md.

THE APPLICATION OF THE RESERVOIR SYSTEM TO THE IMPROVEMENT OF THE OHIO RIVER.

By CAPT. WM. D. CONNOR,* Corps of Engineers, U. S. A.

The control of the flood waters of the Ohio River by means of reservoirs located along its headwaters is not a new proposition but it has recently been revived in connection with the popular demand for radical improvement of our inland waterways.

As early as 1800 this system was advocated in England by Mr. Thomas Telford, C. E., for the improvenment of the River Severn, and in our own country in 1849 Mr. Charles Ellet, Jr., submitted a paper to the Smithsonian Institution on proposed reservoirs at the headwaters of the Ohio. The subject was also studied and reported upon by Mr. W. Milnor Roberts, U. S. Civil Engineer, in 1857, and again in 1870. Col. H. M. Chittenden, U. S. Corps of Engineers, has given the reservoir system mature and able consideration and has submitted probably as much definite information on the subject as has been written in this country.

This method of improvement of the Ohio River was for good and sufficient reasons decided against in the early '70's, when the subject of the improvement of this river was seriously undertaken, and it is a question now whether a sufficient number of these material objections, on which this decision was based, have since been removed to make this method of improvement supersede the present plan for a lock and dam system.

NATURALLY CONSERVED RIVERS.

This method of storing the flood waters of a river's watershed is undoubtedly the ideal one for the purpose of flood protection and regulation of the flow of the stream and it is simply a decision against its practicability that has heretofore prevented its use. The rivers of North America probably give as good types of naturally conserved rivers as can be found in the world. First and greatest of all these is the St. Lawrence River, which has for its storage basins the five great lakes; the next greatest is the Mackenzie River, which is conserved by Lakes Athabasca, Great Bear, Great Slave and hundreds of smaller lakes; and then, conserved by Lakes Winnipegosis, Winnipeg and Manitoba, we have the Nelson, Severn and Albany rivers. The floods rising in the headwaters of the Saskatchewan pour into these lakes and are then stored and distributed gradually to the three rivers last mentioned, and the method of conservation is nearly ideal.

I will not go into the discussion of the advantages of these enormous reservoirs in the conservation of flood waters in a river, because to an engineer who has given river improvement any study at all their advantages are beyond question.

ARTIFICIALLY CONSERVED RIVERS.

Many small streams are to a certain extent regulated by dams across them for water power, but there are only four great rivers in the world on which artificial reservoirs have been created for the purpose of storing flood waters. These are the Mississippi, the Volga and Mtsa, and the Nile. The reservoirs at the headwaters of the Mississippi were constructed by the U. S. Corps of Engineers from 1881 to 1887 and the storage capacity of these reservoirs is approximately 93 billion cubic feet. The Volga and Mtsa can properly be considered as a unit inasmuch as the reservoirs unite their headwaters. Their storage basins were likewise constructed for the conservation of floodwaters and the improvement of navigation. Their storage capacity is 35 billion cubic feet, 20 billion of which can be turned into the Volga and 20 billion into the Mtsa, it being possible to turn 5 billion cubic feet in either direction.

The great dam at Assouan is the latest example of the reservoir system, and although its primary object is for irrigation purposes, its effects are such that it can be classed with the others mentioned above.

OBJECTS OF THE RESERVOIR SYSTEM.

The objects of the reservoir system can be di-

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vided into three parts—flood protection, improvement of the draft of the navigable channel, and the development of water power. Protection against floods has heretofore been considered the first object of the reservoir system, with a secondary effect upon navigation, but the renewal of the discussion has arisen mainly from the demand for increased navigability of the Ohio River and its tributaries, and there is no question but that to-day its relation to navigability is the most important test that must be applied to the system in discussing its practicability.

One of the most alluring arguments for the reservoir system has come into existence since the days of Ellet and Roberts, and is one that appeals very strongly to the public at large; that is, the development of water power at the dams creating the reservoirs. The enormous amount of power that can be so generated is amazing even to those who have looked into the subject casually, and to a person interested in the conservation of our natural resources its appeal is very great. There is no doubt at all that a vast amount of waste energy could be thus harnessed and used, but the figures set forth by enthusiastic advocates of the system, when looked into closely, will be found to be extravagantly optimistic and unworthy of the great consideration that has been given to them.

The question immediately suggests itself to a student of this subject, as to the proper agency by which such a reservoir system should be constructed, and after considering the methods of private, municipal and State enterprise, all three of these must be eliminated; and the Federal Government stands as the sole agent capable of carrying on this great work. It will be claimed by some, and undoubtedly will be urged in Congress, that the Federal Government has no right under the constitution to carry on such a work unless it be in the interest of navigation purely, but this objection may be thrown aside at once, for the implied powers of Congress and its collateral powers are becoming greater year by year. If there be a popular demand for this improvement and if after a careful study it be found feasible and practicable, the necessary authority will be found to do the work, and the necessary funds will be forthcoming.

A great question with Congress will be the cost of the work, and this great initial cost will be urged against the scheme as a potent reason for its rejection. This objection, like the one discussed above, as to the power of the Federal Government to do the work, may be dismissed at once by a broad student of the question. A great initial cost is to-day no cause for rejection for in case the results to be obtained are commensurate with the amount of money to be expended the plan is sure to be adopted.

In a recent article by Mr. M. O. Leighton, Chief Hydrographer of the U. S. Geological Survey (Engineering News, May 7, 1908), this reservoir system as applied to the Ohio River has been gone into at considerable length and *if* his figures as to the flow of streams are accurate, *if* his location of reservoir sites is practicable, *if* his estimate of cost is approximately correct, and *if* the advantages of the reservoir system can be shown to be great enough to offset its disadvantages, there is no question but that the floods on the Ohio River can best be eliminated by this method. These four conditions placed upon his project are not to be lightly considered, nor can they be assumed as surmountable without a great deal more data than is at present available for the study of this subject. I assume the general correctness of Mr. Leighton's data, even though in his list of dams on the Allegheny River he mentions three counties—Valley, Buffalo and Burrell—that are not shown on the map of that State. He undoubtedly has at his command the best available data, and the showing that he makes is quite convincing to a casual reader; but until more data is at hand to fill in some of the gaps, his proposition cannot be accepted as conclusive even in respect to data.

For one thing, his assumed runoff from the headwaters of the various rivers is so much greater than has heretofore been assumed that a more detailed study and gaging of these rivers should be made. According to Mr. Leighton's article, the runoff from the watershed above his reservoirs is nearly four times that from a similar area below his reservoirs. This might be accepted as true if the territory above differed immensely from that below his reservoirs, but to a person who is acquainted with the watershed of the Tennessee River, for instance, it is hard to believe that these figures can be correct, for notwithstanding the fact that the hills are higher in the upper stretches of the river, the middle and lower sections are composed of such rough country that it does not seem possible for the difference in runoff to be so great. Even with 50% of the runoff coming from the headwaters, he is forced to assume that his system of reservoirs can be materially extended in order to give complete flood protection to the Ohio Valley alone.

The main damage done by the Ohio River floods is in the Mississippi River below Cairo and practically all Congressional investigation for flood abatement in the Ohio has been with the view to its effect on the alluvial valley of the Mississippi. With this fact in mind let us look at the effect of the reservoir system on the floods at Paducah, Ky. Mr. Leighton hopes to reduce the flood discharge at Paducah to 830,000 sec.-ft. As a flood protector to the Lower Mississippi the proposed reservoir system would be altogether inadequate and cannot be counted upon, for even this discharge from the Ohio coming in connection with an early flood from the Upper Mississippi and Missouri could cause terrific damage in the Lower Mississippi were it not for the levee system below Cairo.

Even assuming that as far as it goes the data is correct, it must be extensively supplemented, and so elaborate a plan as that of Mr. Leighton, including as it does both final cost and results, seems to be very immature, and certainly cannot be considered conclusive when based on such admittedly incomplete data. Should further investigation show that his physical data is correct, we are but little further advanced than we were half a century ago. Although we would then know the reservoir system to be theoretically successful in the prevention of floods, the great questions of its feasibility and practicability would still have to be proven.

FEASIBILITY.

Almost the only question of importance to be discussed under this head is that of the territory to be submerged by the reservoirs. The river valleys, even near the headwaters of these streams, are becoming yearly more populated, and dotted with towns and villages. The associations that the American people have for their homes and burying places are very great, and there would doubtless be enormous pressure brought to bear on Congress to secure the adoption of some other mode of river regulation.

Mr. Leighton did not combine his tables and show the area submerged, but a study of them shows that more than 1,700 square miles of territory must be submerged in order to give him the reservoir sites therein accounted for. He admits that the list is not final, and the theoretical possibility of his project requires that additional reservoirs must be made before his plan can be considered complete, and we may therefore assume that not less than 2,000 square miles of territory must be submerged to give the reservoirs requisite for full flood protection.

Some of this area is undoubtedly wild land, but even in the wildest parts of the territory in question small farms are being opened up every year along the river bottoms, and a narrow fringe of this bottom land is cultivated in a great majority of cases. The area whose waters he will conserve or partially conserve is about 59,000 square miles, and of this area he will give up one-thirtieth to inundation. Although the greater portion of this conserved area may be wild land of little value, there can be no doubt but that the part inundated will be the choicest of it all, inasmuch as it is part of the river bottom. This area given over to total inundation must represent a very large percentage of the present flooded area of the Ohio Valley since it is equal to a strip of land more than two miles wide extending along the Ohio River from Pittsburg to Cairo.

PRACTICABILITY.

That a possible project from an engineering point of view may not be practicable is axiomatic. To be practicable the advantages must considerably outweigh the disadvantages. The disadvantages of the system may be studied under the following heads: Cost, danger, time of completion, and durability.

COST.—This is the first item that must be looked into whenever a project is submitted that has a semblance of practicability. Many projects whose desirability is unquestioned have been postponed for years because the original cost was so great that Congress did not feel warranted in adopting a plan that called for what at the time seemed to be an enormous expenditure of money. Two such cases may be cited in the history of this country. The first is the improvement of the South Pass of the Mississippi River, and the second is the Isthmian Canal. The plans for the improvement of the South Pass, eventually followed by Captain Eads, were proposed before the Civil War (1852) by a board of engineers from the U. S. Corps of Engineers, and Congress was importuned time and again to give the necessary authority to carry on the work. What would now seem to be an insignificant sum for such a great improvement was at that time too great to obtain from Congress, and not until private enterprise agreed to furnish the money with a guaranteed depth of channel (which incidentally was never obtained) did Congress authorize this important work.

The history of the Isthmian Canal is so new that it need not be repeated, but even the great advantages from a financial and political standpoint of this great enterprise were only able to overcome the opposition a few years ago.

The estimated cost of the incomplete system of reservoirs submitted by Mr. Leighton is about $125,000,000. This is a large sum for Congress to appropriate, even if it represents an outside cost for the entire system, but it is interesting to examine into the method by which this figure is obtained. Mr. Leighton admits that his cost data on the dams is based on very insufficient data, but states that it is the best available. His article leaves no room for discussion as to actual cost, inasmuch as he gives no lengths of dams in his list of reservoirs, and since the cost varies at least directly with the length of the dam for a given height, and in all probability more than directly, this would appear to be a very important omission. He assumes that the capacity of a reservoir may be used as a measure of its cost, and gives a table of costs based on the capacity of his reservoirs.

How erroneous this assumption may be can be illustrated by a single example. The reservoirs at the headwaters of the Mississippi are amongst the largest in holding capacity of any constructed in the world. The largest of these is Lake Winnibegoshish, with a capacity of 45 billion cubic feet. The height of dam necessary to give this enormous storage capacity is only 14 ft., the dam is a timber crib filled with rock, and its cost per million cubic feet of capacity was $3.55.

In estimating his cost Mr. Leighton divides the reservoirs into classes based upon their holding capacity, and of all the reservoirs proposed by him in this class, the lowest dam is seven times as high as the Lake Winnibegoshish dam, and the majority vary from ten to seventeen times its height. Inasmuch as every one of these dams must be provided with enormous flood gates, there seems to be no question but that a masonry or concrete dam will have to be built in each and every case. Any engineer of experience enough to have estimated the cost of a 200-ft. masonry dam knows the utter impossibility of figuring on such cost without the most minute data.

The following are some of the proposed reservoirs in this class, showing the height of dams and capacity of reservoirs in the several cases:

Locality.	Capacity. Cu. ft.	Height of Dam, Ft.
Mahoning Creek, Mahoning, Pa....	22 billion	251
Clarion River, Clarion, Pa.....	24 "	210
West Fork River, Clarksb'g, W. Va.	25 "	100
Cheat River, Tucker Co., W. Va...	24 "	200
Youghiogheny River, Friendsville, Md.	20 "	240
Greenbrier River, Lewisburg, W.Va.	33 "	164
Cauley River, Fayette Co., W. Va..	36 "	250
Little Kanawha River, Gilmer Co., W. Va.....	35 "	97
Licking River, West Liberty, Ky..	23 "	110
Cumberland River, Pineville, Ky..	27 "	110
Sandy Fork River, Smithville, Tenn.	22 "	150
Rockcastle River, Rockcastle, Ky.	25 "	140
Clinch River, Scott Co., Va.....	30 "	180
Hiawassee River, Cherokee Co., N.C.	32 "	200
Little Beaver River Columbiana, O..	27 "	240
Middle Island Creek St. Mary's, W. Va.	25 "	119

In the above list I have only enumerated dams whose storage capacity places them in the same class with the Lake Winnibegoshish dam. Compare these dams with the Lake Winnibegoshish dam and we have on one hand a timber crib dam 14 ft. high and on the other hand a series of masonry dams averaging about 175 ft. in height, and after a single look at the list I willingly submit to the reader the probable accuracy of comparative costs of reservoirs when based on comparative capacity alone.

DANGER.—It is a current saying that human life is held very cheap nowadays, but in spite of this modern neglect of safety precautions the gravest indictment against the reservoir scheme is the danger that exists to the people of the river valleys through a possible failure of a single dam in the valley above them. The dams for this reservoir system will, of course, be as nearly secure as human ingenuity can make them, but the breaking of one of the large dams on the upper part of a tributary would undoubtedly break all the dams below it, and the horrors of the Johnstown flood would be forever forgotten in the awful calamity that would visit all the region of the lower river. Mr. Leighton states that the dangers from these dams to the inhabitants of the valley below cannot be classed with those of an "ordinary morning stroll down the streets of a great city." Making due allowance for the hyperbole of an enthusiast, it would be difficult to make people living in the valley believe that Mr. Leighton was serious in his statement. Our every-day life is based upon faith and confidence in other people doing their duty, but I know of no similar case where the lives of so many thousands and property worth so many millions could be so endangered by a single accident or a single breach of trust.

The interests involved practically necessitate a concrete or masonry dam, and such dams, of established profile, founded on solid rock, are admittedly very stable, but ideal conditions for such structures are seldom encountered. The engineer is forced to use his best judgment innumerable times, and the resulting structure is ordinarily a compromise between what he desires and what he can obtain, and every such compromise offers a chance for a mistake in judgment.

Dams that were considered perfect have gone out frequently in the past and undoubtedly will do so in the future. The calamitous effects of such failures exceed those of earthquakes or fires, and an examination into the possible effects of such failures in the proposed reservoir system will show its potentiality for disaster. Two examples will suffice. The dam on New River at Radford, Va., and the one just above the mouth of the Greenbrier River have a combined capacity of about 80 billion cubic feet. Should the upper of these two dams break, the lower one would also go out, and this mass of water, equivalent to about two-thirds of a cubic mile, would roll down the valley of the Kanawha, leaving death and destruction in its wake beyond human conception. This valley is not a wilderness, but has two railway lines, one on each side of the river, for nearly its entire length, and from Hinton, W. Va., to Point Pleasant, over a hundred miles in length, are cities and villages varying in size from Charleston, the capital of the State, to the smallest country towns.

The second case is the Holston River in eastern Tennessee. Along this river above Knoxville, Tenn., would be three dams with a combined capacity of 300 billion cubic feet, an amount equal to one-twentieth of the normal annual discharge of the Ohio River at Cairo. Should the upper of these break, the others would almost inevitably go out in their turn, and 2½ cubic miles of water would pass Knoxville and tear its way down the Tennessee River valley. No one can tell how far its awful effects would be extended nor how great and terrible those effects would be, but it is safe to predict, as in the case of the Kanawha above cited, that it would cause all former flood catastrophes to sink into insignificance and send the whole nation into mourning.

Will the people in these valleys acquiesce and permit such a sword of Damocles to hang over them? If they will, this objection is removed. If otherwise, and I think I can hear the echoes of a No! that will reach from ocean to ocean, then this objection alone is sufficient to cause the rejection of the whole scheme.

TIME OF COMPLETION.—The disadvantages arising from the long time during which such a system would be under process of construction are objectionable mainly from a navigation point of view. In the canalization of a river the worst stretches can be attacked first, and as each section of river is completed, that section becomes available for navigation, and there is a material increase in the navigable depth for each stretch improved, whereas the benefits from a reservoir system would be small in annual amount and would be distributed over the entire length of the river, and a long period of time would elapse before any material advantage would accrue to the interests of navigation at any particular place. The demand for 9 ft. in the Ohio River is urgent, and it is doubtful whether the public will be satisfied to wait for or to experiment with the advantages of the reservoir system. Planning and building for our children's children is unsatisfactory at best, although commendable in some cases; but the people of to-day want results and want them soon. In the case at hand, 9 ft. navigable depth is wanted within the next few years, and the public will not be satisfied to adopt so slow a method when a quicker one is possible whose good results have already been demonstrated.

DURABILITY.—One of the gravest drawbacks to the reservoir system is that these reservoirs will be continually decreasing in size, owing to the sediment and other material that will be carried into them by their mountain streams. The carrying capacity of a current increases with the sixth power of increase in the rate of the current, that is, a stream with a current of two miles an hour will move an object weighing 64 times as much as will a stream with a current of one mile an hour. This enormous increase in the moving power of a stream applies with alarming directness to the feeders of the reservoir system, which are all mountain streams and many of them mountain torrents. I have no data at hand showing the movement of the bottom of streams, but that such movement is enormous every one admits, and it has been stated that the bottom of the Missouri River moves to a depth of 10 ft.

Even if these reservoirs should not fill up completely for 150 years, yet in 50 years they would have lost one-third of their capacity, and with storage for only 22% in place of the present alleged 33% of the runoff, the system will be practically useless, and other methods would have to be resorted to. When the available reservoir sites have filled up, their utility is ended and no new sites will be available.

The advantages claimed for the reservoir system are (1) flood protection in the Ohio Valley, (2) an increase in the navigable depth of the river so that nine feet or more shall be available at all times, and, (3) an enormous development of power at the dams forming the reservoirs.

FLOOD PROTECTION.—The advantages of a completely conserved river as a means of flood protection are admitted and need no elaboration, but even the physical practicability of this has yet to be conclusively established. The advantages accruing to navigation interests and derived from water power will now be investigated.

NAVIGATION INTERESTS.—As I stated in regard to the question of flood protection, the reservoir scheme would be the ideal one for navigation interests, if a sufficient amount of water can be stored to provide for the low water season, but the amount of storage must be sufficient to give the required flow at the lowest point on the river at which an improvement in navigation is desired. The reservoir on the Upper Mississippi gave an increased depth at St. Paul (357 miles below) of not more than 18 ins., and the effect was apparently lost at Lake Pepin, 387 miles below the reservoir. Emptying water into the upper part of a stream is like pouring water into a constantly enlarging pipe, and the feeders must supply enough water so that the flow at the lower end of the channel is sufficient to give the required depth at that point. This is the controlling factor in the low water supply from flood water, and therefore the study of the conditions at Paducah, Ky., is a study of the controlling factor in the improvement of the navigable depths of the Ohio River by the reservoir system.

Either the commonly assumed data based on many years' experience is incorrect, or else there is something wrong with Mr. Leighton's figures. The normal annual discharge of the Ohio River as given by different authorities varies from 5,000 billion cu. ft. (Humphreys & Abbott) to 6,200 billion cu. ft. (Bulletin E, U. S. Weather Bureau) and 5,600 billion may be assumed as the mean annual discharge. The pilots on the Ohio River say that when the Paducah gage reads about 12 ft. there is usually nine feet of water in the river above; but they say that at times this is not the case, and it would therefore seem that 13 ft. on the Paducah gage would be as little as could conservatively be counted upon to give the desired nine feet navigable depth in the channel above. The discharge of the river corresponding to this gage reading is approximately 190,000 cu. ft. per second, which is equivalent to an annual flow amounting to about 6,000 billion cu. ft. It thus appears that there is not quite enough runoff from the Ohio basin in the normal year to give a nine-foot navigable channel if every drop of rainfall were conserved; and the reader can see the futility of attempting the task with barely 33% conserved. In some years there would be an excess of water, just as occasionally there is without any improvement at all, but in a year like 1887, when the average gage reading at Paducah was only 2 ft. for six consecutive months, such improvement would be totally inadequate.

It therefore appears that without other auxiliary methods of channel improvement, the question of entirely improving the Ohio River by means of a reservoir system can be rejected immediately. No one will question the fact that the reservoirs would aid in increasing the depth of water to a certain extent in the upper part of the river, but to say that it could give nine feet throughout its length is apparently an absurdity.

The reason for this mistake in Mr. Leighton's article probably arises from a river peculiarity with which he is not acquainted through lack of experience in river engineering. This fact is that the bottom of a river flowing in a shifting bed rises as the surface of the water rises and falls as the surface falls; and this is illustrated at every bar in a silt or sand-bearing river like the Lower Ohio. With the gage reading 10 ft. at a certain point there may be 5 ft. of water over a certain bar. As the river falls this same depth may be maintained or the depth may decrease more slowly than the gage reading, and when the gage falls to zero there may still be from 2 to 3 ft. over precisely the same line that gave only 5 ft. depth when the gage read 10 ft.

This is well illustrated by a survey of a stretch of river once made by a new man. He made a survey with due care and plotted his notes after coming into the office; but when he came to plot in his bar lines and show the zero contour referred to the mean low water plane, he found that he had simply a series of pools, each separated by a dam of sand. The reason was that he had made his survey at a high stage of

water when the bottom was raised across each bar.

Mr. Leighton has apparently assumed that if there is 2 ft. depth at mean low water there must be 9 ft. depth when the river is at a 7-ft. stage; otherwise I am unable to account for his deduction in regard to channel depths at Paducah.

There is no doubt but that any system of reservoirs would give an increased depth and would improve the river to a certain extent, but just how much the river would be improved will depend upon how many reservoirs can be actually constructed and what their total capacity will be, taken in consideration with the low water stage at various points along the Ohio River. If the advantages of the reservoir system are found to outweigh the disadvantages, its effect upon navigation should be studied and utilized to the full extent in the improvement of the river. Whatever plan of improvement may be adopted, the least available depth along the river for a period of several years is the depth that the success of the method is to be judged by. A little less than the least available depth is what navigation interests must count upon, and they do not ask for 9 ft. of water only, for they already have more than double that amount every year, but what they want is 9 ft. of water the year round and 9 ft. of water every year. The present data seems to show that this is a physical impossibility by means of the proposed reservoir system.

WATER POWER.—The question of water power is purely a collateral one, for the Federal Government is not in business, and would have absolutely no authority to develop the water power of its streams for commercial purposes alone; but as an adjunct to the improvement of the Ohio River and the flood protection of the same, it has a certain force, and to the public it holds out attractive possibilities.

Just as stated above, in regard to flood protection, and in regard to the improvement of navigation, Mr. Leighton's figures can be accepted to a certain extent, but his estimates must be revised, and the question must be looked at from a business point of view.

The utilization of the energy of flowing streams is an important one in connection with the subject of conservation of our natural resources, and is well worthy of study and development; but there is a proper and improper time to attack such a subject. If there were a market for the power, it would be developed by private individuals, and where there is such a market, private enterprise is developing this power every year to a greater and greater extent. But to say that millions of horsepower can be put on the market in various inaccessible places and sold at $20 a horsepower year to consumers who must install and operate their own machinery, and find their own market for their power, is ridiculous when we realize that power under similar conditions is refused at $5 per horsepower year and is actually bringing to the Federal Government only from 50 cts. to $1 per horsepower year in several localities at the present day.

I recently had occasion to offer a corporation power at $5 per horsepower year for power from a Federal dam in the Upper White River. The offer was refused with contempt, and the prices mentioned above, of 50 cts. to $1 per horsepower year were quoted to me as suitable prices to be paid to the Federal Government. In fact there was considerable indignation in the locality, especially amongst the promoters of the scheme, because the power was not given to them free, or at a purely nominal figure!

The time may come, and in all probability it will come, when Mr. Leighton's figure of $20 per horsepower will be conservative; but that time is not yet here. When an offer of power at $5 per horsepower year was refused with scorn, with coal at $3.75 per ton in carload lots, it is easy to foresee the small amount of power that could be sold at $20 per horsepower year in a locality where the best coal is worth approximately one dollar a ton.

ANTAGONISM OF INTERESTS.—The interests of flood protection and those of navigation and power are diametrically opposed to one another. Conservative and safe flood protection would require that the reservoirs should be kept nearly empty except during the flood season, whereas the navigation and power interests demand that the reservoirs be kept full, and a certain uniform amount allowed to run out every minute of the year. This is putting the case at an extreme, I admit, because even for flood protection a certain amount of water might be kept in the reservoirs, and the power interests might be temporarily satisfied with less than a uniform rate the year round; but flood protection interests would tend to demand a decrease in the amount of water in the reservoirs, whereas navigation and power interests would tend to demand an increase. The commercial partisans for an increase in stored water would be active and would probably obtain their desires over the wishes of the passive department operating the dams for flood protection. Herein would lie an additional danger, because in the effort to keep the reservoirs full for supply through the dry season, some one of the reservoirs might be caught full by an unexpected rainfall or cloudburst and the terrible results heretofore mentioned would be brought about.

CONCLUSIONS.—After a careful study of the reservoir system as applied to the Ohio River, with a view of determining the actual facts in the case, and with no previous intention of disproving the practicability of the reservoir scheme, I am forced to finish my study with a belief that the safety and best interests of the public demand its rejection. We can fight the annual floods, for we know when they come and where they reach, and if any man chooses to gamble with fate and live or build on the river bottom he does so with full knowledge of the results and consequences to be expected. With a reservoir system, no man can tell the results or measure the losses that would be entailed by a single lapse of watchfulness, neglect of duty on the part of the attendants, or unforeseen weakness in the structure itself.

That the reservoir system for flood protection is theoretically possible has never been denied; that it is possible for it to improve the channel depths to a certain extent is not denied; that a great amount of power can be developed and ultimately sold at a profit is not denied, but that the reservoir system is the great "Pooh Bah" for the Ohio River is most emphatically denied. It is impracticable from even a moderately conservative point of view for flood protection. It is a physical impossibility for it to produce the constant 9-ft. channel required in the Ohio, and the figures on the income from its water power are an alluring bait but are extravagant in the extreme.

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[A proof of the foregoing contribution by Capt. Connor was submitted to Mr. M. O. Leighton, author of the paper in our issue of May 7, with an invitation to make answer to the criticisms. His reply is printed below. We have commented on the discussion in our editorial columns.—Ed.]

Sir—I have read the article of Captain Connor with interest. My chief regret is that Captain Connor did not give my paper more careful reading before submitting a reply. Had he done so he would have seen that many of the points of objection that he has taken the greatest pains to emphasize are freely admitted and strongly urged in the paper that he criticizes.

In support of my belief that Captain Connor has not carefully read my paper, a few general features of misconception may well be noted.

First. Captain Connor implies that the paper criticized pretends to be the final word of the author in the final recommendation of the reservoir plan as a panacea for all Ohio River ills. In introducing his discussion of my paper he says:

"*If* his figures as to the flow of streams are accurate, *if* his location of reservoir sites is practicable, *if* his estimate of cost is approximately correct, and *if* the advantages of the reservoir system can be shown to be great enough to offset the disadvantages, there is no question but that the floods on the Ohio River can best be eliminated by this method."

Further along he says:

"Even assuming that, so far as it goes, the data is correct, it must be extensively supplemented, for so elaborate a plan as that of Mr. Leighton, including, as it does, both final costs and results, seems to be very immature, and certainly cannot be considered conclusive when based upon such admittedly incomplete data."

In the opening statement of my paper I exercised exceeding care to express the same sentiments, to obviate, if possible, the error into which Captain Connor has fallen. My statement was as follows:

"This report will be confined to a statement of possibilities. There will be no attempt to prescribe methods for treatment of each local modifying condition that will be encountered in the prosecution of the plan here proposed. * * *

"It is not expected that the facts here set forth will refute all objections made in past years to the conservation scheme. Such, indeed, is not the object. This paper will have served its purpose if it demonstrates that the plans proposed have so many features of promise that it would be a grave mistake to recommend the permanent adoption of a governmental policy that did not recognize the possibilities and *provide for a further and more minute investigation of them.*"

Second. Captain Connor assumes that the reservoir system is proposed "to supersede the present lock and dam system." This quotation appears at the end of his third paragraph. There are several other extended statements and arguments to the same effect, and the final sentence of his article fully demonstrates his misconception:

"It is a physical impossibility for it (the reservoir system) to produce the 9-ft. channel required in the Ohio." * * *"

The above contentions seem gratuitous in the criticism of a paper which contains the following:

"The figures in the following table are given in their present form merely to show the great possibilities of *assisting* navigation with stored water. The final working out of the matter involves considerable labor as well as the minute study of the channel capacity from Pittsburg to Cairo."

Following this is a table showing the increase of stage for different hypothetical periods, and at different cross-sections, based on the estimated reservoir capacities. Following the table is this statement:

"The facts in the above table indicate that, *while it is not possible to maintain a 9-ft. stage from Pittsburg to Cairo with reservoirs alone,* such stage may be maintained along the flatter portions of the river, especially below Huntington, W. Va., except at steep points like the Louisville Falls, where canalization is necessary. * * *

"Of course it will be necessary to canalize, especially in the upper portions of the river; but it is plain as a result of these investigations that it is unnecessary to place a *continuous* line of locks and dams from the head to the foot of the river in order to insure a 9-ft. stage at all periods of the year."

Third. Captain Connor assumes that I have consummate faith in the estimate of costs presented, and he shows in a very conclusive way how erroneous may be the method that was adopted for this estimate. He zealously argues that the length and height of dams are important factors in cost of reservoirs, all of which is thoroughly understood by the merest tyro in engineering. He shows the difference in cost between the Lake Winnibegoshish dam and some of those proposed. These facts are admitted, but it should be noted, in passing, that Captain Connor bases his comparison on one dam, under very exceptional conditions, while my schedule of costs was based on 96 dams. Among those used in my computation were enormously costly dams, involving unprecedented flow damages, like the New Croton and the Wachusett; also the Ashokan, now under construction. There are many others the cost of which was or will be excessive, and surely these large items will have their effect in raising the average, even as Lake Winnibigoshish would have the effect of lowering it. It is therefore manifestly unfair to test a cost estimate, made up from the cost of many dams and reservoirs, large and small, expensive and inexpensive, with the cost of a single dam in an unusually favorable location.

But, assuming that Captain Connor's contention is fair, the value of the estimate that he criticizes is not depreciated in the mind of its author, because said author himself has not high regard for it. He used the best data available, realized their weakness and presented them for what they are worth. This action was in response to a common demand that is made upon a suggestive paper of this kind. The reader desires to know some approximation to the possible cost, and even though it be 100 or 200% in error, his demand is reasonably satisfied if the estimate is based on the best available data. One may be pardoned if he asks whether or not Captain Connor read the following before he entered upon his criticism of the cost estimate:

"It will be impossible to give precise facts concerning the cost of the proposed system. Such an estimate would

require a minute examination of all the physical conditions and a valuation of the property submerged. Relative figures, based upon the cost of construction of similar reservoirs in other places, are the best that can be given at the present time. *It should be emphasized that this is not a final estimate,* and detailed investigation might serve to reduce or increase the amount submitted. * * *

"We will use as a standard of comparative cost 97 artificial storage reservoirs of various sizes that have been erected in America, Europe, India and other places, or which have been projected for erection, with costs carefully estimated. Such a comparison *is, of course, merely relative, and too great weight should not be given to it.* Yet, inasmuch as a wide variety of conditions is covered by these reservoirs, and the costs thereof vary according to such conditions, it may be expected that the reservoirs contemplated in this paper will approximate, in some degree, those costs, and the estimate will have the advantage of being based on work actually achieved or which has had the minute study of competent engineers."

It was unnecessary to state more emphatically that the figures are merely conjectural, and in no sense an estimate, when speaking to engineers, because, by giving the precise basis of the figures, every man can judge for himself as to their value. The entire article is a suggestion of possibilities only, made for the purpose of inducing further investigation, and this matter of cost is obviously the most important and at present the most uncertain of all.

Let Captain Connor assume, if he chooses, that the reservoir system will cost three times my estimate, and it will not be difficult to prove that, even at such a cost, the investment will be enormously profitable. My critic shakes his head mournfully over the large size of the figures, brings out the South Pass and the Isthmian Canal skeletons, and decides that Congress will be a long time in providing for the work. Of course, we have learned to expect deliberation on the part of Congress. The best reply that can be made to his whole discussion of cost is to quote one of his own introductory paragraphs, viz., the eleventh, and especially this sentence thereof:

"A great initial cost is to-day no cause for rejection, for in case the results to be obtained are commensurate with the amount of money to be expended, the necessary funds will be forthcoming."

Having discussed these three points of apparent general misconception, I will consider briefly certain specific criticisms.

Captain Connor claims that the relation of the reservoir system to navigability is the most important test that must be applied to the system in discussing its practicability. This is emphatically denied. Remove from the Ohio River every feature of navigation, or fill the river channel with locks and dams from Pittsburg to Cairo, and the Tennessee from Knoxville to Paducah, and the reservoir project still retains its great justification. Those who have spent long months in a house-to-house canvass of a great flooded district, who have caused to be made expert appraisal of damage to real and personal property, trade and productivity, as the author has had occasion to do, realize that the damage from floods mounts up with astonishing strides.

The critic is captious in his mention of the fact that in the list of dams on the Allegheny River, three counties, namely, Valley, Buffalo and Burrell, are mentioned that are not shown on the map of that State. It seems surprising that one so painstaking and inquisitive in the search for information as he should not have been led to look at his map more closely after he missed these names among the counties. Had he done so he would have found them among the townships in Pennsylvania, and might have concluded that clerical or typographical errors had escaped notice—a slovenly offence, truly, yet one which occasionally creeps in, even into the splendidly edited reports of the Engineer Corps.

Captain Connor observes that my "assumed run-off" from the headwaters of the various rivers is greater than that "heretofore assumed," and therefore a more detailed study and gaging of these rivers should be made. The run-off figures used for these upper tributaries are not "assumed," but actually measured, and herein lies the value of such measurements, because they relieve us of the necessity of using data "that have heretofore been assumed." A brief glance at a rainfall map covering the Tennessee basin, which is especially mentioned by Captain Connor as showing incorrect values for upper tributaries, will reveal the fact that these upper tributaries have the benefit of a 70-in. rainfall, while in the lower valley 40 to 50 ins. appears to be the rule. Add to this intense rainfall the steeper slopes of the upper tributaries and the consequently increased proportion of run-off, and it is not surprising that the percentage from the upper watershed appears nearly four times that from a similar area below.

To the credit of Captain Connor, it should be said that this is not the first time that the enormous run-off of the upper Appalachian has been the cause of astonishment. When results of the first work of the Geological Survey in these mountains were reported grave doubts were expressed by several of our most eminent hydraulic engineers. But they have now been proven beyond controversy, and have been accepted by those who were the most doubtful. A mean annual run-off of from 3 to 4½ cu. ft. per second per square mile is quite likely to cause those who have confined their work to the lower reaches of a river to become incredulous.

Concerning the statement of the effect of the proposed reservoirs on floods in the lower Mississippi, I will refer the reader to a paper by Mr. A. H. Horton, based principally on records of the Army Engineer Corps, soon to be published.*

Complaint is made because the proposed system promises the submergence of one-thirtieth of the land in the Ohio Valley, and it is stated that the river valleys, even near the headwaters of the main streams, are becoming yearly more populated and dotted with towns and villages. I am, of course, ignorant of the source of Captain Connor's information, but this view is not supported by the Census Bureau reports. The counties in which the reservoir sites are located do not, in the majority of cases, show development at all commensurate with the development in counties over the lower parts of the basin. Taking the upper Tennessee and the upper Kanawha as examples, we find that while these counties have increased in population the increase is confined largely to towns and villages, while the rural population has decreased. And this may be expected, because the land, as a rule, is very poor. The logical treatment of our highlands is to set them apart forever for the raising of timber and the conservation of water.

Captain Connor states that the area given over to inundation is equal to a strip more than 2 miles wide, extending along the Ohio from Pittsburg to Cairo. Excellent! I am deeply grateful for the suggestion. What a splendid argument it makes for the reservoir system! Here we have the situation in a nutshell. The present flooded area of the Ohio Valley, 2 miles wide, extending along the river from Pittsburg to Cairo, is the most valuable area, commercially, in all the valley. Yet it is held for the most part absolutely quiescent by reason of flood menace. It is the dream of the manufacturer, the dream of the shipper and of the Army Engineering Corps to see along the Ohio Valley, from Pittsburg to Cairo, a continuous succession of manufacturing plants. Now what promises to make this possible? The flowage of an equal quantity of land, of comparatively worthless character, in the uplands.

My critic has shown in a most ingenious way how great will be the value of a reservoir system for flood purposes. One can readily imagine what would happen should a person in authority go to the owners of those upland areas and offer them, foot for foot, the land bordering the Ohio River free from flood menace. "The associations that the American people have for their homes and burying-places" are, as stated by Captain Connor, truly very great; but how quickly those associations would be forgotten in the mad scramble of those upland people to stake out their claims along the Ohio River! All of which illustrates the fact that it is, after all, an economic question, a question of relative values, and between the high and the low there would be no hesitancy in making a choice.

Much has been said by Captain Connor of the dangers of dam failure, and it would be interesting to know if he has ever given critical review to the history of these catastrophes. It seems hardly likely that he has, for, with the evidence before him, he certainly would not assert that the "calamitous effects of such failures exceed those of earthquakes or fires." He would find little support of his proposition that because an upper reservoir fails it is necessary for all those below it to be overwhelmed. The breaking of dams and the consequent loss of life is a favorite theme in song and story, but what are the *facts?*

We find, on reviewing the matter, that there have been *four* dam failures in the United States that have caused great loss of life—only four—and in each case the cause is definitely determined and inexcusable. It will not be necessary to review the facts here because the interested reader can readily find all the information in engineering literature. These failures are: Williamsburg, Massachusetts, 1874, 140 dead; Johnstown, Pennsylvania, 1889, 4,000 to 10,000 dead; Walnut Grove, Arizona, 1890, 129 dead; and Oakmont Park, Pennsylvania, 1903, 50 to 75 dead.

Surely, when all the dams, large and small, that have been constructed in the United States are considered; when we recount all the high dams that have stood for decades without sign of failure; when we reflect on the present construction of the great dams in the West, like the Salt River, Shoshone, Pathfinder, etc., not to mention the integrity of the Panama Canal, based on a great dam; and finally, when we recognize the enormous strides that are being made in the engineering practice, the thinking, progressive man need spend little time harking back to the horrors of the Johnstown flood. With equal reason might he become frantic over Herod's slaughter of the innocents, for the one was no less criminal than the other, save in the intent.

*The paper is printed on another page of this issue.—Ed.

Every great measure of progress has been greeted with the cry of "wolf," but progress advances none the less. Captain Connor implies in his paper that there is no guaranty that these proposed dams will not have the same defects that were fatal to the dams above mentioned. I am not apprehensive, because I assume that if these dams are ever constructed they will be constructed by the Army Engineer Corps. Can it be possible that I have more faith in the Army Corps than has Captain Connor?

The statement that the reservoir, as an agent of violent death, is not in the same class "with the ordinary morning stroll down the streets of a great city," is not the "hyperbole of an enthusiast," as my critic so graciously declares, but a well-considered statement, based on casualty records which Captain Connor could find and use if he chose to do so.

Complaint is made that the reservoir system will be slow in construction, and the Ohio Valley cannot wait so long for a 9-ft. stage. Inasmuch as it is definitely stated that the conservation system will not produce a continuous 9-ft. stage, the objection falls of its own weight; but I am unable to forbear the remark that no one has observed any indecent haste in the construction of the canalization system of the Ohio. The canalization of the river can be attacked first in the worst stretches, according to Captain Connor's plans, and this will in no wise interfere with the conservation scheme.

I will omit discussion of Captain Connor's statements under the headings, "Durability" and "Water Power." It sometimes occurs that the most effective way to reveal a misconception is to leave a statement in its original condition, unmarked and undiscussed. In this case there is no danger that the engineers of the country will fail to appreciate how narrow is the view and how mistaken are the premises.

Under "Navigation Interests," Captain Connor discusses an alleged mistake of mine, which he charges to my lack of experience in river engineering. Strangely enough, the principle that he has in mind falls under the head of elementary river hydraulics, such as is taught in every engineering school. Therefore, the person who has had the advantage of such training would hardly have to acquire knowledge of the principle cited by "experience in river engineering." But the great point is that I have absolutely failed to make the assumption with which he charges me. He stated that I have assumed that if there is a 2-ft. depth at low water there must be a 9-ft. depth when the river is at a 7-ft. stage. Not only have I not made any such statement or led up to any such conclusion, but I was careful in drafting the paper to avoid a discussion of this kind. It was not a part of the broad problem, and the fact that it has been introduced by Captain Connor indicates that he has misconceived the purpose of my paper.

In conclusion, I wish to state that I am quite hopeful that this conservation scheme will be thoroughly discussed and that its disadvantages will be established by those opposed to the idea. It is apparent, however, that we can hardly expect to receive great benefit from general denunciations, based on sentiment rather than figures, or the aggressive treatment of matters either freely admitted in the original paper or not brought into question in any way.

M. O. Leighton.

U. S. Geological Survey, Washington, D. C., May 25, 1908.

AN UNDERGROUND WATER SUPPLY from a mountain tunnel is being developed by the city of Santa Barbara, Cal. The city has undertaken the driving of a tunnel 19,560 ft. in length, through a mountain. About $200,000 has already been expended and the tunnel is about half completed. The portion already driven has developed underground streams with a flow of about 75 miner's inches, the sale of which is yielding a revenue sufficient to pay the interest on the bonds already issued. It is expected that sufficient underground flow will be developed to supply the entire needs of the city for potable water. In addition it is proposed to bring through the tunnel a pipe line carrying water from a storage reservoir on the Santa Ynez River. This reservoir will be supplied by a drainage basin of 207 sq. miles, with an average rainfall of 22 ins. It will impound 18,000 acre-ft. of water at an elevation of 1,185 ft. above sea level. While this reservoir would furnish an excellent supply, measured by ordinary standards it is intended to use its water for other than household purposes.

THE ROBINSON MINE of the Transvaal is, according to the directors' annual report just issued, the leading mine of the world. An operating profit for 1907 of $4,385,710 is announced, equalling 70% of its total gold production, and dividends amounting to $3,201,000 were paid. The Homestake mine of South Dakota crushed a larger tonnage and the Goldfield-Consolidated of Nevada yielded more bullion, but the palm for profits, the final criterion of mine valuation, remains with the Robinson mine.

A REINFORCED-CONCRETE COLD-STORAGE BUILDING.

By WILLIAM F. TUBESING.*

The resistance of concrete to the conduction of heat and the ease with which it lends itself to monolithic construction make the material particularly well adapted for the purposes of cold-storage houses. Of the many such structures that have been built in recent years, one of the latest and largest is that of the Roth Packing Co. in Cincinnati, the general details of which are treated in this article.

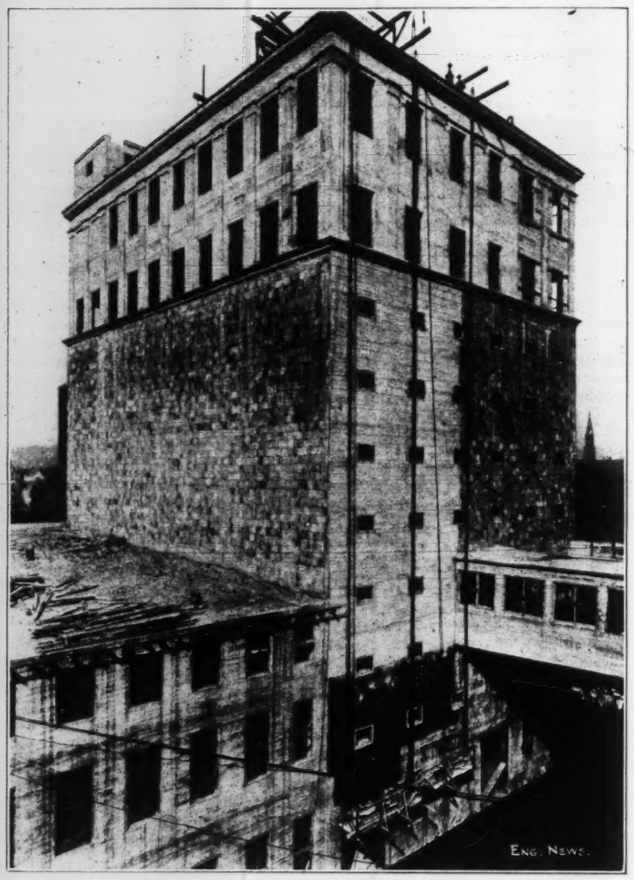

FIG. 1. ROTH PACKING CO.'S COLD-STORAGE HOUSE AT CINCINNATI.
(In course of construction, showing tile facing on walls.)

The storage house is built across the street from one of the old buildings of the works and is connected thereto by a reinforced-concrete bridge described hereinafter. The new work consists of a ten-story and basement main building, eight stories of which are used as cold-storage rooms with the other two as stock and office rooms, and a three-story and basement garage joined to the storage house by a party wall. On the roof of the larger building there has been built a roof garden and a large swimming tank, the bottom of which latter reaches down into the office rooms on the tenth floor. The roof is ornamented with pinnacles carrying incandescent electric globes and a balustrade railing extending between the pinnacles. A rectangular layout, standard reinforced-concrete girder and column construction has been followed, with bearing walls which are reinforced as columns as the girder supports. The main building is 60 × 80 ft. in plan, divided into 20 × 16-ft. bays; the garage is 40 × 79 ft. in bays averaging 15 × 11 ft. in plan.

No especial novelty was introduced into the main design. The columns are 10 × 10 ins. in section with four ¾-in rods, at the roof, increasing by 2-in. steps to 20 × 20 ins. with four 2-in. and four ⅞-in. rods at the basement. They are founded on spread footings (Fig. 2) with a pocket as shown to receive the end of the column. The footings under the walls are also spread to distribute the load except in one side wall of the garage which is carried on a bearing reinforced-concrete beam laid on top of an old masonry wall. These bearing side and end walls are 18 ins. thick at the basement, thinning down to 12 ins. at the top story. Throughout they are reinforced with ¼-in. rods spaced 12 ins. c. to c. each way, with the aforementioned additional vertical reinforcing rods opposite the girder supports.

In order to prevent the sweating of the walls on the outside, the outside 3½ ins. of the walls of the cold-storage stories were composed of 3-in. hollow tile which was afterwards plastered with a ½-in. coat of cement finish and blocked so as to give a dressed stone appearance. The interior of the walls were covered with pitch and a cork insulation applied and the exterior face covered with a cement finish. This construction is shown in Fig. 2. The cork insulation was used throughout the building, laid on a 4-in. slab floor. In the corridors in the cold-storage floors 2-in. Nonpareil cork insulation was fastened to 2 × 4-in. creosoted joists 18 ins. on center. The joists, where there was sufficient head room, were held in place by ⅜-in. bolts, held in the concrete beams, or where the head room was limited 2 × 2 × ¼-in. angles held the joists flush with the bottom of the beams, as shown on Fig. 2. The first floor of the garage is covered with Nonpareil insulation and as it was found that the cork was very elastic, it was feared the 1-in. finish specified would not be sufficient, so a layer of concrete 2 ins. thick and reinforced by ⅜-in. bars 12 ins. on center was placed instead. The large electric trucks which are run onto this floor necessitated a safe and heavy construction.

Probably the most interesting features of the building are the 40-ft. bridge connecting the buildings and the large reinforced-concrete water tank 18 ft. 8 ins. × 30 ft. 8 ins. and 4 ft. 6 ins. deep below the level of the roof with a 15-in. projection, 4 ins. thick, above the roof, making a total depth of 5 ft. 9 ins.

As the bridge is 30 ft. above the street, it would have been necessary to use a great amount of centering if it had been built of rod reinforced concrete. In order to obviate this, it was decided to place a 20-in. 65-lb. I-beam on each side of the bridge from the new to the old building. These I-beams were designed strong enough to carry the falsework and the concrete up to a point A-A (shown in the detail, Fig. 4); after having set a week it was concreted to B-B, and after another week the remainder of the bridge was concreted. The I-beams rested on 11 × 11 × ⅜-in. bearing plates. In order to carry the heavy live load of the electric truck, the I-beam in conjunction with the ¾-in. bars acts in the beam 5 ft. deep and forms part of the wall construction. In the tank shrinkage stresses were duly taken care of by an abundance of steel, as shown by the section in Fig. 3. The cement mixture was mixed with an abundance of a waterproof compound, and as an extra precaution the inside surface of the tank was given two washes of 1:1 cement mortar. The 24 cast-iron bulls-eyes were designed to offer plenty of resistance to the passage of water around the joints by thin collars about 2 ins. on center. The casting was of cast iron and was ½-in. thick. A lighter plate glass could have been used, but ¾-in. was decided on. This is held against the main frame by a ½-in. cast-iron ring held in place by ten ⅜-in. brass tap screws. The joint is made water-tight by a finished bearing surface with a ⅛-in. rubber collar resting between the finished surface and the glass plate. Section A-A (see Fig. 3) shows the details.

The basement in the main building and garage is used as a wash room for the hams, and for this purpose reinforced-concrete tubs 3 ft. 2 ins. × 4 ft. 8 ins. with 4-in. walls were built upon a 10-in. cinder base. These tubs were built in rows along the walls and in double rows along the center line of the columns.

The concrete for the footings was a 1:3:6 mixture and that for the floors and walls a 1:2:4 mixture. The mixing for everything but the footings and basement first floor was done in the basement. Holes were left temporarily in the front basement walls. The mixer was placed with the dumping end directly in front of the hoist. The bucket of the hoist was allowed to sink into a pit, at the bottom, receive its charge and be conveyed to the top, where it was dumped into a receiving hopper, which was opened and closed by the gate tender as the men came up with the bucket wagons, which they wheeled to the position of placing over runways, so as not to disturb the placing of the steel. The engine and hoisting apparatus were placed on the street and steam piped to the mixer and cables led to the hoist and elevator, which occupied the other elevator opening.

The interior walls were poured from the floors above, by means of openings left in the floors. The form work for the walls was moved from story to story by an electric hoist. The frame and hoisting apparatus was hoisted from floor to floor, and kept from tipping by means of bags of sand.

The floors used for storage purposes were designed for a live load of 200 lbs. per sq. ft; the

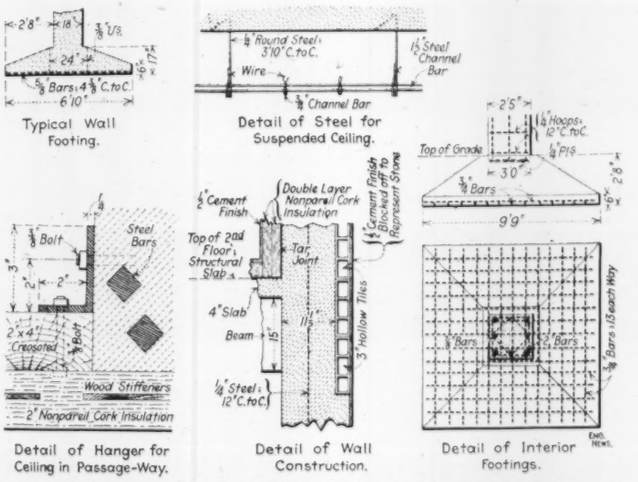
Typical Wall Footing.
Detail of Steel for Suspended Ceiling.
Detail of Hanger for Ceiling in Passage-Way.
Detail of Wall Construction.
Detail of Interior Footings.

FIG 2. WALL AND FOOTING DETAILS OF THE ROTH REINFORCED-CONCRETE COLD-STORAGE BUILDING.

*514 Pabst Bldg., Milwaukee, Wis.

ninth and tenth floors for 100 lbs.; the roof for 50 lbs., but to this an additional load of 125 lbs. for dead load due to 15 ins. of earth for the garden must be added. The footings and piers were laid on blue and yellow clay, the bearing power of the soil being taken at 4 tons per sq. ft. Eighty per cent. of the live load was assumed to come on girders and columns.

The work progressed at the rate of a story in 15 days, including walls. Again the speed and efficiency showed what it means to systematize the work and have men in charge each of whom knows what is required of him. Thus the concrete foreman, the steel foreman and the carpenter foreman, each directly under the superintendent, take the direct superintending of the various parts off his hands, and give him a greater range of usefulness. The time-keeper again takes an unnecessary burden from the shoulders of the foremen and also provides data relating to the cost, efficiency of the men and progress of the work and looks after the various items of material, which would otherwise go to the superintendent. Well executed working drawings and plenty of details with careful engineering supervision see that same are properly executed and little obstacles promptly overcome.

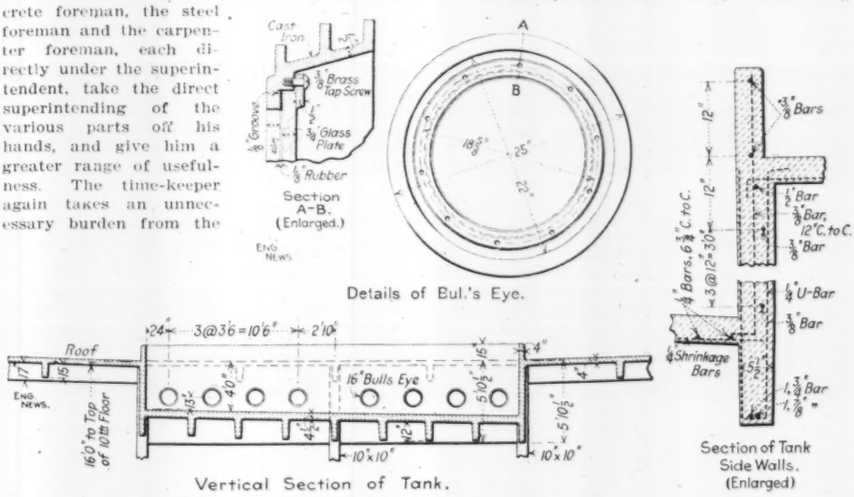

FIG. 3. DETAILS OF TANK.

The architect for the Roth Building was Anthony Kunz, of Cincinnati, O. The work was executed by the Ferro-Concrete Construction Co., of Cincinnati, O., the writer representing that company as engineer.

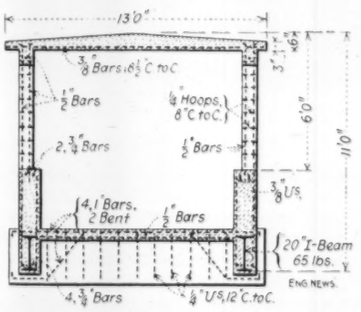

Fig. 4. Bridge Between Buildings, Roth Packing Co., Cincinnati, O.

A PORTABLE AIR COMPRESSOR PLANT, driven by gasolene, has been assembled by the Link Belt Engineering Co., of Philadelphia, Pa., for use in their construction work at points where no power supply is available. The details are all of standard manufacture, and can be modified to suit special conditions. In this instance the engine is a "Lackawanna" two-cylinder 5 HP. marine gasolene engine, the gasolene being stored in a small tank supported above the air pump, which is a Westinghouse Traction Brake Company's D-2 water-jacketed type, connected by gear and pinion to the engine shaft through a friction clutch. The carbureter is placed between the engine and pump. Sparking current is furnished by a small magneto dynamo resting on a sheet-iron platform and driven by frictional contact with the rim of the engine flywheel. Both pump and engine are water-cooled, the former being driven at about 200 r.p.m.; the air reservoir has a capacity of 6 cu. ft.

FIREPROOF BUILDING CONSTRUCTION AND CONCRETE BUILDING CONSTRUCTION.

Two valuable reports on the above named subjects were presented at the recent convention of the National Fire Protection Association in Chicago by the Committees on Fireproof Construction and Concrete for Building Construction. These were read by Mr. Edward T. Cairns,* as chairman of both committees, and we present herewith abstracts of both.

FIREPROOF CONSTRUCTION OF BUILDINGS.

A standard for a fireproof type of building construction is an important matter to many business interests, and the best results can be obtained by these various interests working together. We believe there is a good prospect for the appointment of a conference committee consisting of various national associations of architects, engineers, builders and fire protection engineers. We recommend that this association indorse the plan and appoint a committee for the work.

If the preparation of a standard is undertaken on this basis, it will probably be found desirable to make it more extensive than the field of fireproof construction, and very likely to cover the entire scope of ordinary city building ordinances. Such an undertaking will, of course, require considerable time, and some patience would have to be exercised in awaiting the results. We believe, however, that it is the only proper basis on which to undertake so important a work.

The rapid increase in the number of fireproof buildings during the past few years makes it quite natural that the past twelve months should have witnessed an unusual number of important fires in buildings of that class. We call attention to a few of the more important, and to improvements in the art of fireproof construction which these incidents suggest as necessary and practical.

The fire of Jan. 10, 1908, in the Parker Building, New York City, is perhaps the most conspicuous example.† This was a typical city building, 12 stories high, of somewhat more than average area. It was generally considered as a fairly good structure, but it was defective (as are many similar houses in various cities) in that it had unprotected stair and elevator shafts communicating with rooms on many different floors in which were stored large quantities of inflammable merchandise; it had inadequate tile insulation on metal frames; the columns were of cast iron instead of steel, and the outside windows were chiefly of unprotected ordinary glass.

This combination proved beyond the control of the fire department, and resulted in a loss to the building of 65½% of the sound value above foundations, and a nearly total loss of about $1,000,000 worth of contents. If the elevators and stairways had been properly enclosed and outside windows had been protected, it is probable that the fire would have been controlled on the floor in which it originated, as the firemen would have been able to concentrate their attention upon that floor and possibly to extinguish the fire before the structure had been injured to the point of collapse.

Another important fire occurred on March 10, 1908, in the 12-story fireproof building of good average brick, steel and tile construction, 32 to 36 West 18th St., New York. The fire originated in an adjoining building of ordinary construction. It was soon beyond control in that building and lapped around the front wall into the windows of several stories at once of this fireproof building, burning out its contents and resulting in a loss of about 6% to the structure. In all probability, if standard wired glass windows had been installed on the street front of this building, as on the sides overlooking the exposure, the fire would have been kept out and little damage would have resulted.

A still more striking example of the necessity of properly safeguarding window openings on fireproof, as well as on other buildings, is afforded by the fire in the Keith Building at 144 Wabash Ave., Chicago, on Jan. 28, 1908. The building was of ordinary steel and tile type, seven stories high, 63 × 157 ft., occupied throughout by a wholesale millinery house. The fire originated in a wall-paper store facing on State St. It soon became beyond control, and fanned by a high wind, extended entirely across a 40-ft. alley and through the ordinary unprotected windows of the rear of the Keith Building. It ignited its millinery stock on the four upper floors, with the result that the contents of these floors were entirely consumed and the building itself was damaged to the extent of 28.3% of its sound value. All of the trimmings and fixtures and most of the tile in the four stories, and part of the steel work in roof was ruined and had to be replaced.

Still another loss on a modern fireproof building, due to exposure against unprotected windows, occurred in Chicago on Jan. 27, 1908, when the new Corn Exchange Bank Building at La Salle and Adams Sts. was damaged by the burning of an adjoining hotel. The bank building was under construction, and had not progressed far enough to contain any appreciable amount of combustible material in the shape of wood flooring, trim, etc. It was entirely unoccupied. The damage was confined almost wholly to the burning out of window frames on most of the floors above the third. The loss in this case was nominal, probably about 4%, but the exposure was severe enough to have resulted in a very disastrous fire had the bank building contained any quantity of combustible contents.

The prevention of a large part of such losses is quite possible. It is hoped that if the general conference above suggested is finally arranged, such methods of reducing these losses may be agreed upon as will appeal to the general public and will be adopted in the erection of important buildings in the future which shall be more deserving of the term "fireproof" so loosely applied at the present time.

Among the features to be considered by such a conference would be the following: 1. The regulation of height and area of buildings to dimensions such as allow control of fire in combustible contents by whatever extinguishing agencies, public or private, may be provided. 2. The safeguarding of all interior vertical openings to prevent spread of fire from one floor to another. 3. The design of really fireproof partitions in place of the flimsy and largely combustible makeshifts so common at present. 4. The protection of all exterior wall openings (including front windows) against exposure fires and against the lapping of fire from story to story of the same building. 5. The limitation of the use of cast-iron columns. 6. Satisfactory means protecting metal work from heat by suitable material of proper thickness securely fastened in place; one of the most important defects of present methods of insulating steel work is the insecure manner in which the insulating material is held in position.

Another common weakness in so-called fireproof buildings will probably be found very difficult to overcome. This is the presence of a very large value in destructible decoration and equipment.

In the adjustment of the Baltimore conflagration losses, as reported by the National Board of Fire Underwriters, the eight most important fireproof buildings averaged as follows, as to percentage of value of various items and percentage of damage thereon:

	P. ct. of total sound value of bldg.	P. ct. of damage to item.
Foundations	5.5	2.5
Steel frame	13.19	12.93
Mason work	31.31	53.125
Equipment	19.27	62.52
Trim and finish	29.99	84.18
General expense (fees, etc.)	4.53	61.59

Before buildings can be properly classed as fireproof, some means will have to be found for reducing the proportion of these easily destructible values. Of course, something will have been accomplished in this direction when wall openings shall have been properly protected to restrain internal, and keep out exposure fires; and when floor openings shall have been protected, and interior partitions built so that internal fires can be confined to the locality in which they originate instead of being allowed to spread throughout the building. Perhaps it is in this latter direction that our efforts can best be expended.

REINFORCED-CONCRETE CONSTRUCTION.

The section of the building code of the National Board of Fire Underwriters is a satisfactory standard which should stand until a conference of the several interests engaged in concrete and other fireproof construction can meet and agree on a code which shall be generally ac-

*76 William St., New York, N. Y.
†Engineering News, May 21, 1908.

ceptable. Attention may be called to a few fires occurring recently which demonstrate in some measure the fire resistance of concrete.

A most interesting fire occurred Feb. 18, 1908, at Dayton, Ohio, in the new factory of the Dayton Motor Car Co. and was reported at some length in the "Quarterly" of the National Fire Protection Association, from which the following is quoted:

The building is the newly constructed monolithic reinforced concrete construction, six stories high. It adjoined and communicated through unprotected openings with a five-story brick building of ordinary construction. The concrete building was of pier and curtain-wall construction. Piers in basement, 25 × 25 ins. and spaced 22 ft. c. to c.; bays supported by same class of girders spaced 7 ft. c. to c., 9 × 11 ins.; beams from piers, 12 × 17 ins. The piers decrease in cross section, until at roof (or sixth floor) they are 12 × 12 ins., except under foundation for sprinkler tank, where they are 19½ × 19½ ins. Roof of same class of construction, but with lighter structural members. Floors of monolithic, reinforced-concrete construction, supported on the beams and girders. Wood floor on first attached to wood nailing strips laid in concrete. Same devices used for giving initial supports to wood running boards to attach electrical wires.

Between each outside pier, both in exterior and area walls, there is a 4-in. concrete curtain wall extending about 3 ft. from floor. On this rest ordinary, light, wood sash and thin glass, making a very large area of this inferior class of construction.

One large open elevator and one stairway at same point. The fourth floor where the fire started was occupied as upholstering and trimming, also storage of motor cars. Fifth floor was painting department and this floor was practically vacant. Fire was discovered by outsider at 12.45 a. m. and was first noticed about midway on the west side. The occupancy made a hot quick fire which spread rapidly throughout this portion of the floor and through the unprotected openings into the brick building, which latter was practically destroyed except the walls. The fire department helped keep the fire from spreading, and also helped confine it largely to the fourth floor of the concrete building.

The only floor on which fire gained a foothold was the fourth, where it originated. The mass of combustible material therein was sufficient in one section to spoil the concrete covering on one pier and numerous girders. The concrete has fallen off some of the girders, on lower edges, exposing the metal reinforcement. The action of the heat has calcined the concrete to such an extent as to make some of the girders defective against another attack. Our inspectors do not consider the integrity of the supports impaired against ability to sustain load, but only against fire. There was scarcely 5/7-in. of concrete about the bottom of the reinforcing members, which is totally inadequate and not in accord with best practices.

The heat caused about 2 ins. of the concrete floor to disintegrate. In one instance, directly above the hottest part of the fire, the action extended to and through the ceiling of fourth floor. The mass of combustible material on which flames fed, was comparatively small; had the fire been long sustained, as in a general conflagration, the concrete structure would have failed and one floor would have wrecked the one beneath.

Water seeped through the concrete floor and about the risers for both the steam heating and the sprinkler system and damaged stock more or less on every floor. The sewer becoming clogged, water stood 10 ins. deep in the basement and wood bodies of motor cars were somewhat damaged.

The damage to this building was adjusted at 8% of its sound value, which, by the way, was a definitely known quantity as the building was quite new. The building was far from being fireproof in the proper sense of the term, owing to its large ordinary glass walls and unprotected floor openings, and also its inadequate insulation of steel reinforcement. That the fire did not spread throughout the house and destroy its entire contents is due to the efforts of the fire department, rather than the character of the construction. Still, it must be conceded that the concrete itself stood the test very well indeed, especially in view of the fact that the ordinary building adjoining was much more seriously damaged by the same fire and under the same fire department protection.

Another fire of universal interest occurred Dec. 13, 1907, in the Huyler Building, 134 East 18th St., New York. Here concrete made a very favorable showing, and the value of protected stair and elevator shafts and of wired glass in outside windows, as a protection against the spreading of fire from one floor to another was demonstrated. The building was about 50 × 80 ft., ten stories high, of steel frame with 6-in. concrete floors. The sides of beams and girders were protected by 2 to 3 ins. of concrete, and the lower flanges by 1 in of plaster keyed on by wire. Steel columns were covered by 2-in. terra cotta blocks, and the entire interior coated with about 1 in. of ordinary plaster. Floor surfaces were of decorative tile 6 × 6 × ½-in. Stairs and elevators were enclosed in good tile walls with fire doors on each story. Front windows were of ordinary glass, but those on the side and rear were of wired glass in metal frames.

The fire started about 7.10 p. m. from unknown cause in the ninth story, used chiefly for the storage of empty cartons and paper stock in considerable quantities. It was in the vicinity of the front stair shaft, but did not spread through this shaft (as is usual) on account of its being cut off from the rooms. It soon extended toward the rear of the room and attracted the attention of employees who attempted to use private hose, and the fire department responded to alarm by the thermostat system. The department carried the hose streams up the stairway and through the adjoining building, and eventually extinguished the fire after most of the contents of the ninth story were ruined. The plaster was all knocked or burned off the walls and ceilings, and all the windows (both ordinary and wired glass) were broken out. There was no fire damage on other floors, except that the wired-glass windows in the tenth story rear were badly cracked from flames lapping up from below, and the stone sills of these windows were badly spalled. These windows, however, kept the fire out of the upper floor and undoubtedly prevented a serious loss to contents in that story. There was no damage to steel work and very little to tile or concrete covering of same, and the loss to the building as a whole was adjusted at about 4% of value, being chiefly confined to destruction of wood trim, plastering, painting and tile floor surface.

Ordinarily, a fire starting among inflammable materials as high up as the ninth story results in a serious loss. In this case, the fact that the fire was discovered and the department called early, and that each story of the building was quite effectually cut off from the others, and the structure was non-inflammable itself, reduced the damage to both building and contents to a small fraction of what it might have been under less favorable conditions.

On May 27, 1907, a fire occurred in Merritt Bros. factory at Camden, N. J., which in a building of ordinary construction would doubtless have resulted disastrously. It proved, under the circumstances, to be chiefly a demonstration of the fire resistive quality of the building. It is a five-story structure for the manufacture of metal clothes closets for factories. The columns, beams, floors and roof are of heavy type reinforced concrete, the mixture being 1:2½:5, using small-size crushed trap rock. The walls are of brick carried on a concrete frame. The fifth story was occupied for painting and drying. In the corner of the room were two wooden gas-heated drying ovens approximately 7 × 10 × 8 ft. and along the side of the room next to this were a number of smaller ovens, all of metal construction. These two wooden ovens had been filled with freshly painted metal to be dried. An employee endeavored to light the gas under the oven and he either dropped his torch or the burners failed to ignite properly so that the paint and drip pans close by caught fire and the flames promptly extended into the oven.

The fire lasted from ½ to ¾-hour, practically burned up the wooden ovens and some other light inflammable materials close by. The flames did not extend very far into the room, however, though there was enough heat to melt out the soldered metal frames of the wire glass monitors on the roof a little to one side of the ovens, and melt the links on two fire doors, 40 to 50 ft. away. The concrete columns and ceiling in the immediate vicinity of the fire showed some cracks, but no material injury, and absolutely no repairs of any sort were made to the concrete after the fire, the only repairs being to the above-mentioned wire-glass window frames.

On May 30, 1907, a fire destroyed the factory of the Waverly Paper Box Board Co., Waverly, N. J., and afforded a test of concrete. The entire plant had plain 12-in. solid concrete walls one-story high. The floors were also of concrete, but the roof was wood and was entirely consumed, with the combustible contents of the buildings. The walls seem to have been of fairly good gravel concrete and suffered some damage from cracking and dehydration of the cement at the surface, but as a whole may be said to have resisted this fire about as well as brick would have done; they have since been used in the rebuilding of the factory.

CONCRETE BLOCK CONSTRUCTION.

There have been no notable changes in methods of manufacture or use, though the industry has been greatly extended. The National Association of Cement Users has recently adopted a standard specification for the manufacture of these blocks.* This standard, of course, is not based wholly on requirements of fire resistance, but is designed to produce a good block. It will doubtless have a marked effect on the quality of blocks produced throughout the country. The U. S. Geological Survey investigation into the question of concrete blocks is still being carried on and considerable progress has been made, but the results have not yet been published.

Only three fires in buildings of concrete block construction have been reported to your committee which seem to warrant special mention.

One occurred in Nashville, Tenn., in the summer of 1907. This was a four-story building, 50 × 170 ft., with walls of two-piece concrete blocks and a wooden joisted interior, occupied throughout by a retail furniture store. The top story and attic were completely burned out, but the damage to concrete block walls was nominal and easily repaired. The test could not be termed severe, but the blocks made a very creditable showing under the circumstances.

The second fire occurred Dec. 9, 1907, at Anderson, Ind., in a three-story building just completed, but not occupied. The house was fitted up for an Old Peoples' Home. It had ordinary single-piece hollow concrete-block walls and wooden interior, and was of fairly good size, containing 40 living rooms, office, dining rooms, etc. The entire interior was burned out, but the walls stood with very little damage, except at the top and around windows, and have been used in reconstruction.

The third fire occurred at Murfreesboro, Tenn., April 29, 1908, in a basement and two-story building, 60 × 115 ft. It was occupied in basement and first story for the storage of hay, grain, feed, cotton and hardware; the second story as a roller-skating rink. The walls were 10-in. single-piece hollow blocks; floors and roof of ordinary joist construction. Fire started in the first story and burned from 9.30 p. m. till midnight. The blocks appear to have been of rather poor quality, made with crushed stone aggregate and quite porous. All walls above the first floor fell, the rear and front walls being completely down with the exception of several lower courses of blocks of rear wall. The only weight carried by the walls was the dead weight of the second floor and roof, at the time of fire the second floor (skating rink) being unoccupied.

Beyond considerable chipping and small amount of spalling, the limestone foundation which formed the basement wall is not badly injured, and with repairs, may be used again. The total damage to the building and contents is estimated at $10,000.

Unequal expansion between the outer and inner shells of blocks was clearly demonstrated by the rear wall, where the bond between the outer and inner shells of blocks was cracked continuously almost the entire length of the remaining wall.

This was undoubtedly a long, hot fire and furnished a more severe test of the blocks than the other two fires mentioned above. It seems to justify the following opinion of this committee expressed in last year's report:

Well-made blocks are suitable for small buildings, where no high temperatures or long-continued fires are to be expected, but the hollow form in which they are made, absolutely precludes their being classed as highly fire-resistive or suitable for fire walls, or for any buildings which may be subjected to severe fire.

*Engineering News, Jan. 16, 1908.

A LONG SPAN TIMBER ROOF TRUSS.

By J. C. LATHROP,* Assoc. M. Am. Soc. C. E.

A typical example of the boldness and resourcefulness of the engineers and architects in San Francisco, in the period immediately after the fire, when material was scarce and high priced, was shown in the design and construction of the roof truss for the Coliseum Skating Rink.

This building is located at the corner of Oak and Baker Sts., and the feature of principal interest from an engineering standpoint is the long span roof trusses, constructed almost entirely of timbers of small dimensions, ten of which support a roof area of 120 × 220 ft. These trusses have a clear span of 120 ft. and are spaced 20 ft. c. to c. The lower chords are made up of seven pieces, 1 × 10 ins. each, reinforced by a steel plate on the bottom 6 × 5/16-ins. The upper chords are made up of eight pieces 3 × 8 ins., four on each side, 3 ins. being allowed between the sections for the diagonals and tension rods. The lower chord is made in the form of an arc of a circle, the flexibility of the material of which it is composed lending itself admirably to such construction. The upper chord is straight, being inclined at a pitch of one to three. Care was taken not to splice more than one piece at the same section. The diagonal struts are 8 × 8-in. timbers and all vertical tension members consist of two steel rods.

The purlins are 3 × 12-in. timbers spaced 3 ft. 6 ins. c. to c., and carry a corrugated iron roof. The trusses were assembled complete on the floor of the rink, and then raised to place by means of two gin poles.

The surprising thing about the design is that a total gross load of only 20 lbs. per sq. ft. was assumed in figuring the stresses in the various parts.

*Linden, N. J.

TWO NEW CLUBS, made up largely of engineers, were formally opened in New York City last month. Both are located in the top stories of the new Hudson Terminal Buildings, whose basement is to be the downtown terminus of the Hudson company's tunnel system. One of these clubs, the Machinery Club, has its headquarters in the Fulton Terminal Building, the other, the Railroad Club, is located in the Cortlandt Terminal Building. The officers of the Machinery Club are F. H. Stillman, President; R. C. McKinney, Vice-President; Walter L. Pierce, Treasurer; Theodore Waters, Secretary. The officers of the Railroad Club are E. H. Gary, President; F. D. Underwood, Vice-President, and C. W. King, Secretary and Treasurer.

THE BLOCK SIGNAL TRAIN INDICATING AND EMERGENCY SAFETY EQUIPMENT OF THE INTERBOROUGH RAPID TRANSIT CO., IN THE EAST RIVER TUNNELS, NEW YORK CITY.

It will be remembered by most readers of this journal that this latest extension of the New York subway system is through two tubes from Bowling Green, on the extreme lower end of Manhattan Island, to Borough Hall, Brooklyn. Construction is well under way on the still further extensions of the system in Brooklyn Borough. These notes, however, are entirely concerned with the operating equipment of the two tubes mentioned.

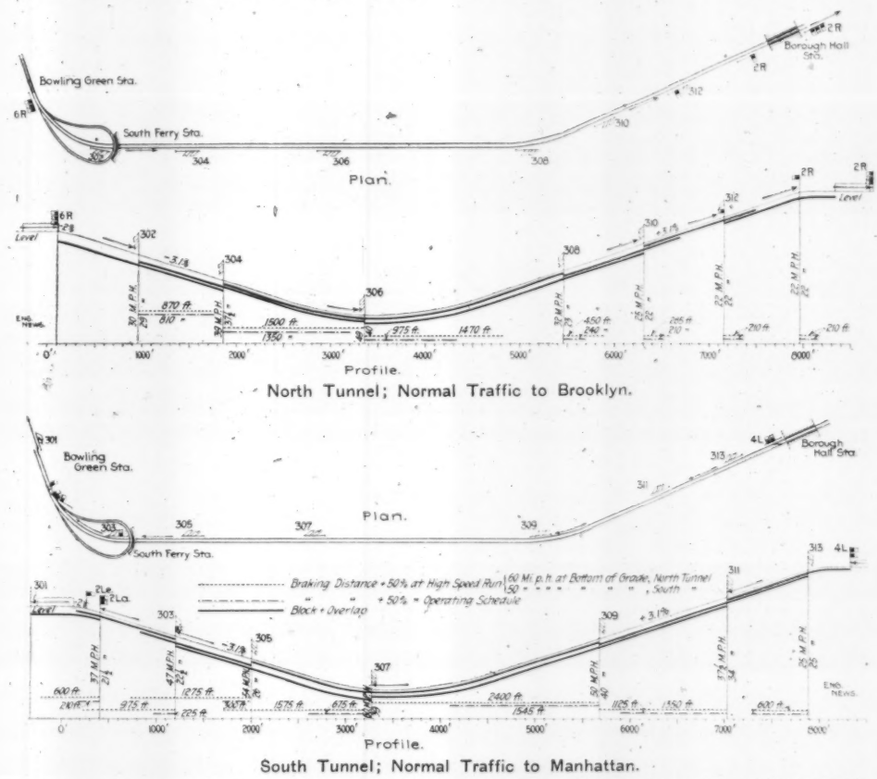

FIG. 1. ARRANGEMENT OF BLOCKS AND SIGNALS; SUBWAY EXTENSION OF THE INTERBOROUGH RAPID TRANSIT CO., UNDER EAST RIVER.

The equipment of this 17,000 ft. of tube is necessarily somewhat different from that in the rest of the subway system, and this difference may be largely attributed to two causes. The first of these is the necessity of operating the regular subway trains through the tubes with the very small clearances which have been allowed between the cars and sides. The other cause may be stated as the desire to promote every safeguard against possible disaster as the result of any accident such as the traveling public may think peculiar to subaqueous tunnels and to thus inspire public confidence in the safety of the system.

The signal system is a development of that in use throughout the subway, and the changes from the older apparatus have been made largely on acount of the reduced clearances, though they, of course, also comprise those minor improvements which the subway operation has shown to be advisable. The signal apparatus designed more especially for these tubes will be used throughout on the Brooklyn extension and to a certain extent in the whole subway as replacement becomes necessary.

The return of the direct current operating the trains is by one rail only—the other rail of the track being divided by insulating joints into blocks of predetermined length for the signaling. The arrangement of blocks is shown in Fig. 1. It will be seen that the lengths of the blocks is that of two complete overlaps except toward the end of heavy up-grades, where the overlap is shortened. Thus the blocks vary from 800 to 2,400 ft. As in the subway generally lights only are used for signaling; red and green on the "home" signal for "stop" and "proceed," yellow and green on the distant signal for "caution" and "proceed," respectively. In the older subway signal case the color of the signal is determined by a slide operating between a continually lighted lamp and a clear-glass lens. In the signal case used in these tubes the color indication is given by separate colored-glass lenses in front of incandescent electric lamps which are properly lighted and extinguished by auxiliary direct-current relays.

A pair of 550-volt alternating-current feeders, No. 4, B. & S. gage, run the length of both tubes overhead. This circuit is run in duplicate to avoid possible interruptions. To these feeders are connected the primary windings of what have been called "track" transformers, located at each signal. These transformers have two secondary windings; one with a 10 to 1 ratio of transformation, the other with a 50 to 1; the one secondary gives current at 50 volts and the other at 10. The 10-volt secondary winding is connected across the rails at the beginning of this track section. Across the rails at the opposite end of the track section is connected the track relay, the moving element of which operates a contact controlling the direct-current relays (for lighting the signals) and the direct-current air valves for setting or releasing the train stops. This direct-current circuit is connected to mains extending the length of the tubes and is fed by 16-volt storage batteries in the Borough Hall and Bowling Green stations. Each battery is charged, by a motor-generator set, from the third rail and track circuit. A cast-iron grid of one ohm resistance is in series with the 10-volt track circuit at the transformer end of the section and there is another similar grid at the relay end. These are to prevent excessive current, either alternating or direct (train propulsion), in the signal circuits. A low-resistance impedence coil is placed in multiple with the a. c. relay. Current for the actual lighting of the signal lamps is taken from the 50-volt secondary of the track transformer mentioned before. It is now seen that the alternating current for the signal lamps is switched on and off by direct-current relays whose operating circuit is opened and closed by the track relay which is in turn operated by low-voltage alternating current from the rails. The actual arrangement of track and relay circuits to properly accomplish this is seen in Fig. 2.

The expresses from the Lenox Ave. branch (it will be recalled that the subway divides into an eastern and a western branch at 96th St.) go to Brooklyn, with one half those from the Broadway line (the western branch), while the other half from the latter branch go to the South Ferry terminus. As will be seen from Fig. 1, these Broadway trains in making the loop at South Ferry pass over the Brooklyn tracks, as these are considerably depressed at this point. The junction of the uptown track from Brooklyn, having a 3.1% grade, with the South Ferry loop presented a few problems in allowing a two-minute headway train-service from Brooklyn and a four-minute service from South Ferry. It seemed necessary that the trains from South Ferry should skip the Bowling Green station and that all delays occasioned by stopping the incoming Brooklyn trains on a steep up-grade should be eliminated so far as possible. To insure the rapid dispatching of all these trains it was found advisable to give the Bowling Green operator control of signals and stops at both ends of both tubes. That he might know the progress of trains through the tubes at all times an automatic illuminated profile of the tubes was designed. Fig. 2 shows that the indication of each "home" signal in the tubes is repeated on this device, which is shown in Fig 3. It consists essentially of a box 4 ft. long, 2 ft. high, 1 ft. deep, with a glass front and with a certain arrangement of interior compartments

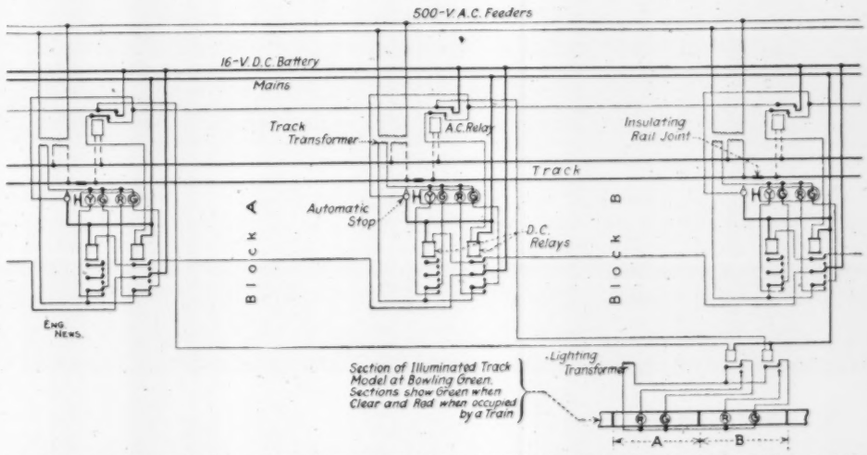

FIG. 2. TYPICAL SIGNAL, TRACK AND INDICATOR CIRCUITS OF THE INTERBOROUGH RAPID TRANSIT CO., IN THE EAST RIVER TUNNEL, NEW YORK CITY.

to represent the blocks of the tubes. All of the glass is made opaque, except the parts representing the tubes, which are subdivided, by the walls of the compartments mentioned, so that each block can be illuminated independently of every other one. Each section is lighted by red or green electric lamps, according as relays are operated from the "home" signals at the different block points of the tubes. When a tube is clear this device shows a green line for that tube and the position of train when in the tunnel is shown by having the particular block occupied shown in red.

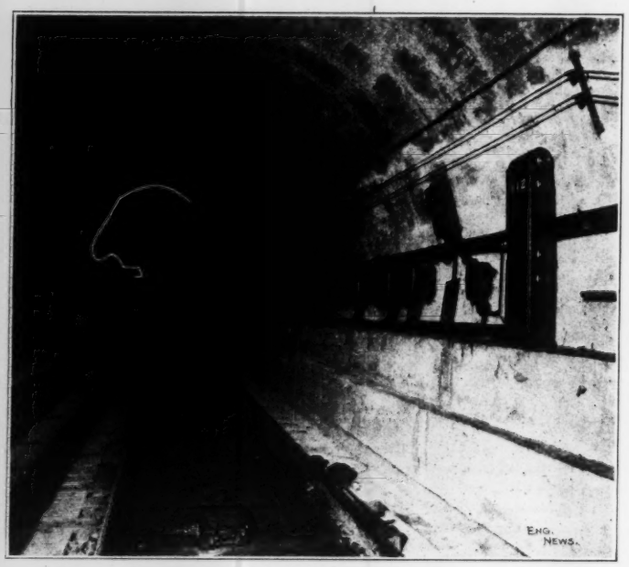

FIG. 3. BLOCK SIGNAL APPARATUS AS ACTUALLY INSTALLED IN EAST RIVER TUNNEL, NEW YORK CITY.

The interlocking switching plants are so connected that, in case it is desired on account of repairs, accidents, etc., trains can be sent through against the normal direction of traffic. After the Bowling Green operator has signaled the Borough Hall operator to send a train through in such reverse direction and after the train has entered the first block of the tube, then both interlocking machines are so locked that neither operator is able to change the signals or to send another train into the tube from either direction. When the train in question has emerged from the tube, then the former conditions are restored and trains can be sent normally or against traffic, as before, at the judgment of the Bowling Green operator.

At first it might be thought that a train could not be sent against normal direction of traffic on account of automatic stops, but a study of Figs. 1 and 2 will show that the train clears its passage ahead of itself in so running. Under normal running when a train enters a new block the "home" signal just passed and the one a block in the rear goes to "danger," while the "distant" signal of the block two blocks back goes to "caution." The automatic stop at the entrance of the new block, however, remains down, the one a block back comes up and the one two blocks back goes down. In running against traffic, on tracks so equipped, then the train automatically lowers the stop at the other end of the block entered and sets the one two blocks away.

A 2-in. pipe line for the supply of air necessary to operate switches and automatic stops runs through each tube and connects with the Brooklyn and Manhattan substations, which have heavy, motor-driven air compressors. Smaller, auxiliary, automatic, motor-driven compressors have been placed at each end of the tubes for action in case the supply of air from both substations should be interrupted. The pipe lines carry a pressure of 75 to 80 lbs. per sq. in. Expansion joints of the common piston type are fitted to all pipe lines in the tubes about every 1,000 ft.

An important change has been made in the electro-pneumatic track switches used on this latest work. The electrically operated valve controlling the air supply to main switch pistons has been placed in a steel box on the wall and the pipes leading from the air main and to the switch pistons have insulating joints so that this valve is entirely insulated from the track voltage. The switch-piston mechanism is boxed in with asbestos lumber. The third-rail guards at switch points are reinforced with heavy asbestos lumber at the back, for the greater protection of workmen.

Each night a careful inspection of switches, signals, stops, junction boxes, relays, impedence coils, transformers, lamps, fuses and track-wiring is made, and all insulating track-joints are carefully cleaned to remove all conducting material. The electrical circuits are tested at noon each day. There are two maintainer's crews, for these East River tunnels, each of which works from its respective end in both tubes toward the center.

About every 300 ft. through each tube is placed a group of emergency apparatuses, consisting of a telephone, fire alarm and emergency alarm, which in being operated automatically throws the power off both tubes. At these stations there is a fire extinguisher, an outlet of a fire line with a certain amount of hose and a kit of emergency tools. A wooden hand rail runs along both sides of each tube at such a height, above the bench formed by the conduit, that it may be readily grasped by any person who may find it necessary to walk in the tunnels.

To clear the tunnels of smoke, which might result from an accident and which might induce a panic among passengers or possibly interfere with their proper exit in time of trouble, an arrangement of blowers, ducts and air nozzles has been installed as shown in Figs. 4 and 5.

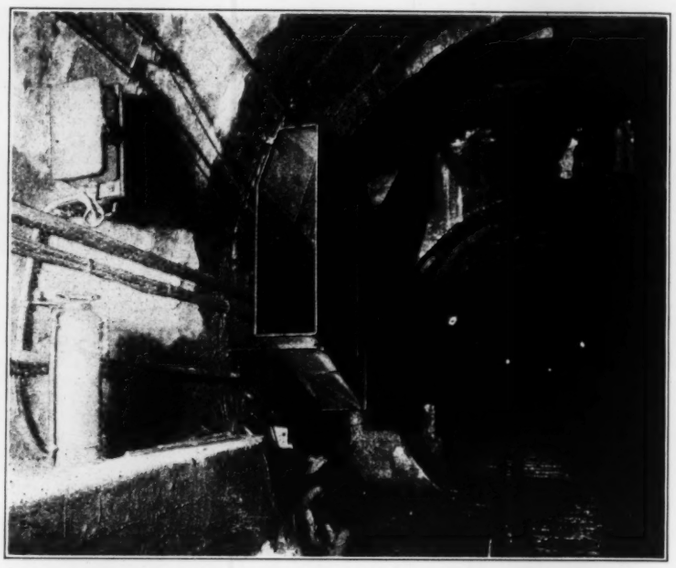

FIG. 6. AIR NOZZLE OF EMERGENCY VENTILATING EQUIPMENT IN EAST RIVER TUNNEL, NEW YORK CITY.

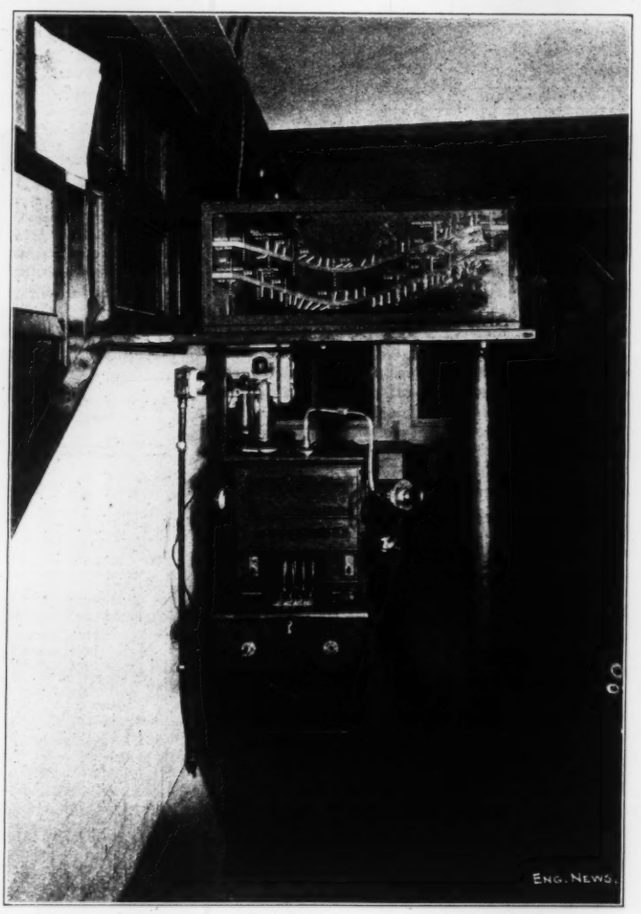

FIG. 4. AUTOMATIC TRAIN INDICATOR, BATTERY TUNNEL, NEW YORK CITY.
(Telephone Switchboard Shown Holds Connections for all Emergency Stations in the Tubes.)

Into each tunnel at both ends has been introduced a large nozzle on the end of ducts leading from the blowers. The fans at either end of the tubes can be started by the Bowling Green operator, who also controls the electro-pneumatic dampers which pass the air into one tube or the other. He would be expected to start that fan which would clear the tube of smoke quickest or best assist in the escape of passengers by the shortest route, as he would know from his illuminated chart and from the alarms turned in the exact place of trouble.

Four sump pits are provided along the tubes at points shown on Fig. 6. The sump at the lowest level has a double pump equipment the arrangement of which is shown in plan and elevation by Fig. 7. Each of the other three pits has a single pump outfit of the same general arrangement shown in each half of Fig. 7. All these pumps are driven by compressed air from 3-in. air lines running through both tubes. The air for pumping is furnished by separate compressors at each terminal of the tubes. The drainage is discharged through 8-in. pipe lines laid under the tracks. In addition to these stations a pump car has been constructed and equipped with electric motor driven pumps. It can be run in under its own motive power and after throwing out as much suction hose as is found necessary and connecting its discharge to an outlet of the 8-in. line it can reinforce the sumps.

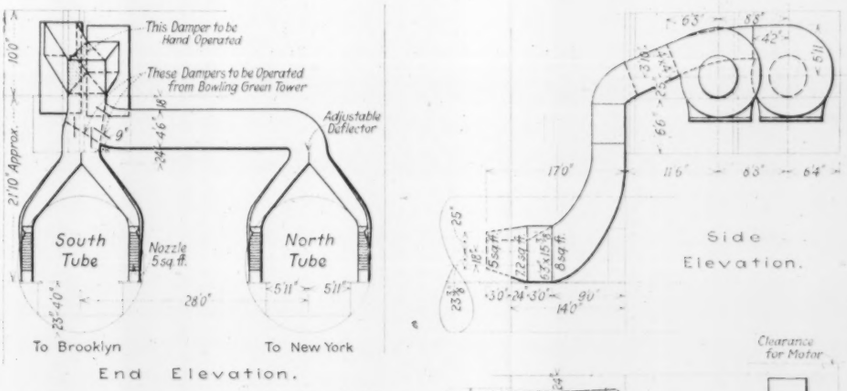

FIG. 5. PLAN AND ELEVATION OF BLOWERS, DUCTS AND AIR NOZZLES FOR EMERGENCY VENTILATION OF EAST RIVER TUNNEL; INTERBOROUGH RAPID TRANSIT CO., NEW YORK CITY.

THE EFFECT OF THE CONSERVATION OF FLOW IN THE OHIO BASIN ON FLOODS IN THE LOWER MISSISSIPPI.

By A. H. HORTON,* Assoc. M. Am. Soc. C. E.

The great floods in the Lower Mississippi are the result of great floods in the Ohio basin. Consequently, if the Ohio River floods are checked the benefit will be extended to the Lower Mississippi. This paper is the result of an attempt to determine from a review of actual records the contribution made by the Ohio basin to Mississippi floods, and the effect produced on the latter by flood conservation in the former. The following facts are shown:

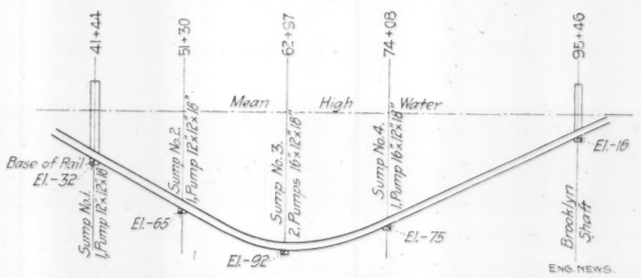

FIG. 7. DISTRIBUTION OF SUMPS; EAST RIVER TUNNEL, NEW YORK CITY.

(1) That the Missouri basin, by reason of its great area of flat country, is slow-spilling and floods therein do not rise with rapidity sufficient to gorge the channel of the Lower Mississippi.

(2) That the Upper Mississippi basin, although subject to more rapid fluctuations in flow than the Missouri, is very much smaller than the latter and could not originate floods of capacity sufficient to gorge the Lower Mississippi.

(3) That the Ohio basin discharges at maximum flow 50% more water than the Missouri and Upper Mississippi combined, and as the basin is a quick-spilling one, it practically alone is the cause of floods in the Lower Mississippi.

(4) That inasmuch as it has been shown to be possible to reduce floods in the Ohio, the same means will also reduce to a point well within the capacity of the Lower Mississippi channel all the floods that are likely to visit that channel.

The present consideration of this matter appears specially timely because of the present agitation of the question of conservation of natural resources, of which the water resources take first importance, and in view of the recent publication in Engineering News of Mr. M. O. Leighton's report to the Inland Waterways Commission on "The Relation of Water Conservation to Flood Prevention and Navigation in the Ohio River."† It is quite important to demonstrate that the great benefits that would be derived from such a conservation system are not confined to the Ohio basin alone.

The writer has collected some interesting data upon the three rivers which form the Lower Mississippi, and, in what follows, has endeavored to bring out the fact that the Ohio practically controls the Lower Mississippi and has shown what would be the effect upon the Lower Mississippi of controlling the Ohio.

Of the three great tributaries which form the Lower Mississippi, the Missouri has much the largest drainage basin, being about three times as large as that of the Upper Mississippi and 2½ times that of the Ohio; but on account of its location in the semi-arid and almost arid regions of northwestern United States, it is the least important. The Upper Mississippi is supplied with a moderate rainfall which in combination with its comparatively small area renders its flow much less than that of the Ohio. The valley of the Ohio, alone of the three tributaries, lies within the zone of copious and, in some parts, heavy rainfall. This makes the flow of this stream of prime importance in any study of the Lower Mississippi River.

The Ohio has a much more southerly origin and course than either the Mississippi or the Missouri. Its extreme northerly sources are about 40 miles south of Buffalo and its southerly sources are less than 100 miles north of the center of Alabama, or about 300 miles from the Gulf of Mexico. Physiographically speaking, the Ohio is the best established for, although the Mississippi is probably of the same age, the upper part of its basin was much more extensively modified by the ice during the glacial period, only a small portion of the Ohio's drainage being affected at that time and but little change was produced in the topography of any except a small portion of the extreme northeastern part of its basin. In consequence of this condition, the channels of the Ohio and its tributaries are fully developed and fixed. Their beds are incised in the underlying rock, and their waters are clear except at the time of floods.

The headwaters of the affluents of the Ohio drain the steep and rocky slopes of the western side of the Appalachian Mountains, a condition which causes the heavy rains to rush into the streams with little or no opportunity for absorption by the soil, and once in the streams the water hurls itself down the steep slopes to the lower reaches of the river, where the slope is low, producing the devastating floods for which the Ohio is famous.

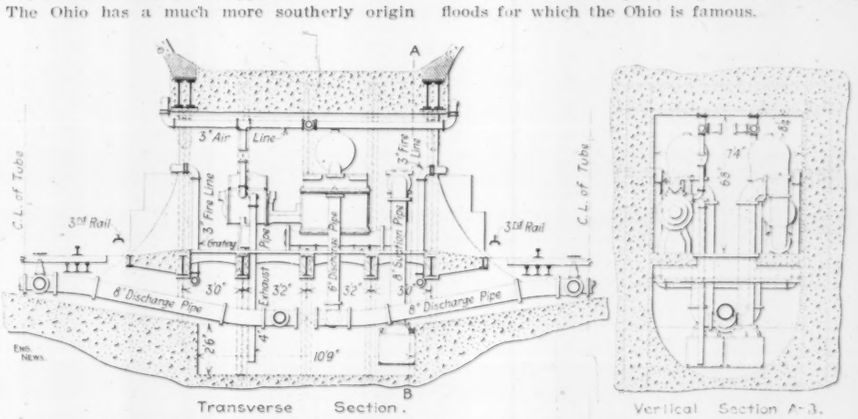

FIG. 8. PLAN AND ELEVATION OF APPARATUS IN SUMP NO. 3; EAST RIVER TUNNEL, NEW YORK CITY.

The Gulf of Mexico exerts a great influence upon the rainfall of the Ohio Valley. By means of the southerly winds which prevail in the lower valley of the Mississippi, the moisture-laden airs

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†Engineering News, May 7, 1908.

from the gulf are carried up the Mississippi Valley and are deflected northeastward up the Ohio Valley until they strike the upper slopes of the Appalachian Mountains, which causes them to precipitate most of their moisture in heavy rains. It is said that the lower lake region and the St. Lawrence Valley form the highway for about 85% of all the storms in the United States.

On account of the southerly situation of the Ohio, it is the first of the three great tributaries to feel the effect of the gulf. During the months of January, February and March, at which time the headwaters of the Mississippi and Missouri are frozen fast, the warm rainstorms from the south come up the Mississippi and Ohio valleys and produce heavy rainfall over the Ohio Valley, and especially at the headwaters. It naturally follows that these three months are the season of greatest rainfall combined with the spring melting which releases the locked up precipitation of the winter and in consequence the great floods of the Ohio occur in these same months, and seldom occur after March, although there are notable exceptions to this rule.

The drainage area of the Ohio above Paducah is about 204,000 square miles, the mean annual rainfall is about 45.4 ins., ranging from 35 ins. along its northern boundary to 70 ins. in the southeastern part at the sources of the Tennessee. The mean annual flow is about 300,000 cu. ft. per sec.; the maximum flow is in the neighborhood of 1,500,000 cu. ft. per sec., being about 30 times the low water flow. About 44% of the rainfall passes off as run-off. The mean annual flow of the Ohio is considerably greater than that of the St. Lawrence River, even though the drainage area of the Great Lakes is nearly twice as great as that of the Ohio. The yearly flow of the Ohio would raise the surface of Lake Erie about 30 ft.

The respective percentages of the discharge of the main stream supplied by the Ohio, Upper Mississippi and Missouri are 31, 18, and 14. The remaining 37% is supplied by streams between the mouth of the Ohio and the Missouri and by the tributaries below Cairo.

The movement and melting of the great ice sheet which covered so large a part of the upper Mississippi basin during the glacial epoch produced a very marked effect upon the topography of the basin; the courses of the rivers were changed, drainage lines were altered very extensively and the surface was covered with innumerable lakes and swamps. According to the Tenth Census there are between 5,000 and 6,000 lakes in the Upper Mississippi drainage basin and all these lakes and swamps have a decided effect upon the regimen of the river. The Upper Mississippi flows through a comparatively level country, parts of which were originally very heavily forested and are now covered with secondary growths. Its drainage basin is 171,500 sq. miles in area, extending nearly to the Canadian line, about 350 miles farther north than the Ohio's watershed. The mean annual rainfall is about 30.5 ins., varying from 25 ins. at its northern boundary to 40 at the southern boundary. The mean annual flow is about 125,000 cu. ft. per sec., the maximum flow is in the neighborhood of 360,000 cu. ft. per sec., being about 12 times its low-water flow. About 33% of the rainfall passes off at run-off.

The Missouri River drains the arid and semi-arid region of northwestern United States. Its channel is not deeply incised and the burden of sand and silt that it carries is greatly in excess of that moved by either of the other great branches of the Mississippi. The northern boundary of its watershed extends into Canada, being some 500 miles farther north than the northern boundary of the Ohio's drainage basin.

There are about 527,000 miles in its basin, of which only a small part lies in the humid region. The mean annual rainfall is about 19.5 ins., varying from 10 ins. in the semi-arid regions to 40 at the eastern boundary. The mean annual flow is about 100,000 cu. ft. per sec.; the maximum flow is in the neighborhood of 600,000 cu. ft. per sec. About 13% of the rainfall passes off as run-off. About two-thirds of the total amount of suspended matter in the Mississippi immediately below Cairo comes from the Missouri.

Table I gives a comparison of these three streams. A study of this table shows that although its drainage area is only one-third of the combined Mississippi and Missouri, the mean and low-water flow of the Ohio is 1.3 times as great as their combined flow and its maximum flow is 1.5 times as great. Table I shows also that the Ohio's rainfall is about twice as great, that its run-off per square mile is 4.5 times as great and that the proportion of rainfall that passes off as run-off is about 2 times as great. Its maximum flow is 4 times that of the Upper Mississippi and 2.4 times that of the Missouri.

From the foregoing, when it is further considered that the Ohio basin is subject to heavy rains at the season of the year when the ground is frozen and covered with snow to a greater or less extent, and that the heaviest rains fall on the headwaters where the soil is rocky and the slope of the surface of the ground is steep, it is easily seen that the Ohio River is the controlling tributary of the Mississippi River and it is axiomatic that any scheme whereby the floods of the Ohio are reduced or controlled will produce almost the same effect upon the floods of the Lower Mississippi. The benefits to navigation and the reduction in height of the floods on the Lower Mississippi, thereby insuring the safety of the levees, resulting from such control of the Ohio, should be considered in counting the cost of a reservoir system on the Ohio River for the aid of navigation and flood reduction.

As has been stated, January, February and March are the months of heaviest rainfall in the Ohio basin and the months of May and June in the Mississippi and Missouri basins. In consequence the usual order of the floods of the tributaries of the Mississippi is as follows: The Ohio, Cumberland and Tennessee all together; the Upper Mississippi and Lower Missouri; then the Upper Missouri. The other western rivers may accompany either or both of the two latter floods. Floods on all the tributaries at the same time have never been known to occur. Such a coincidence would produce a calamity of unparalleled magnitude, the region below Cairo adjacent to the river would probably resemble an arm of the ocean rather than a river during such a flood.

Table II shows the maximum discharge in cu. ft. per sec. of several floods on the Mississippi River at Cairo, the maximum discharge of the Ohio at the same time, and the proportion of the discharge of the Mississippi that is supplied by the Ohio.

From incomplete investigations that have been made on some of the tributaries of the Ohio River, it has been determined that about 18% of the drainage area above Paducah can be conserved by means of reservoirs. It may be assumed that with more maps and more detailed investigations sufficient reservoir sites may be found to conserve one-third of the drainage area, for less than half the basin of the Ohio is covered by contour maps. Furthermore the amount of water discharging at any time would be reduced by more than the same percentage, because the areas above the reservoir sites cover the areas of heaviest rainfall and steepest topography, which produces a larger run-off.

In Table III is given the amount the maximum stage of the Mississippi at Cairo for different years would be reduced with one-third of the area of the Ohio conserved.

With the reservoirs only half full at the beginning of the low-water season an additional flow of 200,000 cu. ft. per sec. could be maintained for three months, which would produce a stage of about 13 ft. on the Cairo gage. This estimate takes into account the flow of the Mississippi above Cairo and assumes that the rivers maintain a low-water stage for three months. Inasmuch as the low-water stage does not persist for so long a period it is safe to assume that the stage would be more than 13 ft. during the greater part of the three months.

In studying the effect of controlling the floods of the Ohio River, upon the high-water stages of the Mississippi below Cairo, the situation is somewhat complicated on account of levee construction and the forming of crevasses during high floods.

Before the construction of levees the river would overflow its banks into the St. Francis, Yazoo, White, and Tensas basins and other basins farther down. Since the construction of levees which had been done actively previous to 1897, and has been continued since then, these basins have been gradually closed.

A discharge curve determined at any section may apply for only a short time, due to the shifting nature of the river bottom; also to the fact that levees may close a flood basin above the discharge section, thereby forcing a large quantity of water through the section which passed around it at the time the discharge relation was determined. Very frequently before the maximum stage was reached along a leveed stretch of the river a crevasse would occur, permitting a large amount of flood water to escape from the river and the maximum stage that would have been reached had the water passed the discharge section can only be estimated. It has been stated that the vertical oscillations of the bed of the river itself conform in a great measure to the changes in stage. The levees at the present time have been strengthened and raised so that the flood of 1907, which has been exceeded but six times in the past 40 years, was carried down for 975 miles without a single break. This fact speaks well for the efficient supervision of the construction and maintenance of the levees by the Mississippi River Commission.

In Table IV there are given the amounts that the crests of the floods of different years would have been decreased at various points on the Lower Mississippi River, with one-third of the area of the Ohio conserved by reservoirs. The reader should not lose sight of the fact that the conserved area is not rendered unfit for cultivation or other use, but that only a small portion of the conserved area is so utilized that its value

TABLE II.—MAXIMUM FLOOD DISCHARGES OF THE MISSISSIPPI AND OHIO RIVERS.

Year.	Maximum discharge: Mississippi at Cairo.	Maximum discharge: Ohio at Paducah.	Percentage the flow of the Ohio is of the Mississippi.
1880	1,250,000	970,000	78
1881	1,330,000	830,000	62
1882	1,700,000	1,230,000	72
1883	1,700,000	1,270,000	75
1884	1,690,000	1,440,000	85
1892	1,440,000	923,000	64
1893	1,530,000	974,000	64
1897	1,690,000	1,275,000	75
Mean	1,540,000	1,114,000	72

TABLE III.—AMOUNT THE MAXIMUM READING OF THE CAIRO GAGE WOULD BE REDUCED BY RESERVOIRS IN THE OHIO RIVER DRAINAGE AREA.

Year.	Reduction in gage height at Cairo.
1880	7
1881	5
1882	7
1883	7.5
1884	8.5
1885	7
1892	6
1893	6
1897	7

TABLE IV.—THE AMOUNT IN FEET THAT THE CREST OF VARIOUS FLOODS WOULD HAVE BEEN REDUCED AT DIFFERENT SECTIONS ON THE LOWER MISSISSIPPI HAD ONE-THIRD OF THE DRAINAGE AREA OF THE OHIO RIVER BEEN CONSERVED.

	1882.	1883.	1884.	1892.	1893.	1897.
Cairo	7	7.5	8.5	6	6	7
Memphis	7	7	8.5	5.5	5.5	7
Helena	6	6.5	7	5	5	6.5
Mouth of White River	8	8	9.5	6	6	8
Lake Providence	8	8	10	6	6	8.5
Vicksburg	8	9	11	6.5	7	9

TABLE I.—COMPARISON OF THE UPPER MISSISSIPPI, MISSOURI AND OHIO RIVERS.

	Missouri.	Miss.	Ohio.	Miss.	Ohio.	Mo. & Miss.	Ohio.
Drainage Area	527,000	171,500	204,000	171,500	204,000	698,500	204,000
Area Ratio	1	0.3	0.4	1	1.2	1	.3
Mean Flow Ratio	1	1.3	3.0	1	2.4	1	1.3
Max. Flow Ratio	1	0.6	2.4	1	4.0	1	1.5
Low Flow Ratio	1	3.2	5.3	1	1.6	1	1.3
Relative Run-off per sq. mile	1	3.9	7.8	1	2.0	1	4.6
Relative Rainfall	1	1.6	2.3	1	1.5	1	2.0
Relative per cent. of rain as run-off	1	2.5	3.4	1	1.3	1	2.2

for cultivation is destroyed—that part which is covered by the reservoir amounts to only a few square miles for each conserved area.

The 1907 flood was within 2 ft. of the highest recorded flood and there was no break in the levees, but there is no way of telling what would have happened had the 1907 flood reached the record stage. It is not the ordinary flood that causes damage but the extraordinarily high water which causes so much havoc and destruction. After years of security from inundation sections that were formerly overflowed at frequent intervals have been immune from floods and in consequence have become thickly settled and built up; if then the levees break under pressure of a record flood the damage done would be enormous. Granting that Table IV may be 50% in error on account of deficient data, it is seen from what would have been the effect of Ohio reservoirs upon the extraordinarily high floods of 1882 and 1884, that what would be a record breaking flood on the Mississippi River would be reduced to an ordinary flood of little or no danger.

In Table V is shown the amount that the minimum low-water during 1882 would have been raised by an additional net flow of 180,000 cu. ft. per sec. at several points on the Lower Mississippi River, which would be available from the reservoirs of the Ohio River if they were half full at the beginning of low water and emptied in three months. While this additional amount of water may not increase the actual depth of water available for navigation by the amount shown in the table, it would have that tendency and its general effect would be very beneficial to navigation conditions.

TABLE V.—AMOUNT IN FEET THAT THE MINIMUM LOW WATER AT VARIOUS SECTIONS ON THE MISSISSIPPI RIVER WOULD BE INCREASED BY THE FLOW FROM RESERVOIRS IN THE OHIO RIVER DRAINAGE AREA.

Locality.	1882.
Cairo	10
Memphis	7
Helena	11
White River	9
Lake Providence	7.5
Vicksburg	9

The year 1882 was by no means an extremely low-water year. The increase in stage due to increasing the flow is greater the lower the discharge, due to the fact that the increment of discharge increases rapidly with increasing stage.

From what has been said it may be granted that it has been shown that the Ohio River exercises a controlling influence over the Lower Mississippi in flood, that the disastrous floods come from the Ohio and that, with the Ohio River controlled by a reservoir system, the floods of the Lower Mississippi would be reduced to such stages as would cause little or no apprehension. By such water conservation water power sites on the Ohio River and tributaries would be increased two or three times in value, navigation on the Ohio and Mississippi Rivers could be improved with a minimum amount of construction and a maximum of efficiency. Freight rates would be reduced to a minimum, the saving to the manufacturers and producers, brought about by the competition of water carriage with railroads, would pay for the total cost of the scheme in a very few years.

The overflow lands adjacent to the rivers, which are among the most fertile in the country, could be cultivated and developed without the apprehension of a devastating flood. The development of these lands in the past few years has exceeded that of any other section of the country. With the knowledge that it was a certainty that no flood would overtop the levees and that no breakage would occur during floods, which is guaranteed by the careful supervision of the Mississippi River Commission, these lands would be developed much more rapidly and extensively.

Reviewing all these benefits it would appear that their value to the country as a whole would be many times greater than the cost of the conservation works, that the reservoir system should be constructed and that all the component parts be completed so that the maximum use could be made of this great natural trafficway, situated at the center of trade and commerce in the United States.

A STRUCTURAL PLANT IN THE PHILIPPINES.

By ROYAL J. MANSFIELD,* Assoc. M. Am. Soc. C. E.

Up to about two years ago there was no plant in the Philippines fitted to manufacture structural steel. There were several fairly well equipped machine shops, including foundries for brass and iron castings of small size, but the fabrication of steel bridges and similar structures had not been attempted. With the developments going on all over the islands, it seemed therefore that a field was open for such a plant, and the Atlantic, Gulf & Pacific Co. has met this requirement.

Situated at the junction of the San Juan and Pasig rivers, just in the outskirts of Manila, with the railway within a short distance, the plant possesses first class shipping facilities. The raw material, which is brought in from abroad, is taken to the shops on the same lighter which receives it from the ship, and, after fabrication, may be as easily loaded once more for transportation, either by land or water.

While the shops do not yet possess all the tools to be found in many of the large modern plants, there is sufficient machinery in operation so that a great variety of work has been satisfactorily turned out. During twelve consecutive months, an average of over 400 tons per month was fabricated, the greatest output being about 800 tons in one month. A short description of some of the structures built by this plant may be of interest.

The Pasig River Bridge is a double track structure built for the Manila R. R. Co. across the Pasig River within the city limits of Manila. It is a drawbridge, but built at a sufficient elevation to allow passage of most of the river traffic without the necessity of being swung.

The superstructure is of heavy construction, built after Cooper's specifications—E 30 loading. All the steel work, including the mechanism for the swing span, was fabricated at the new shops. It is a fair sample of what may be done with Filipino labor, and the workmanship will compare favorably with work turned out in the States.

Considerable work has been done in tank construction, but the 100,000-gallon elevated tank shown herewith is perhaps the most important structure so far. Particular attention has been paid in designing to providing for the typhoons and earthquakes which occur in this region. The wind pressure was assumed at 70 lbs. per sq. ft., which is probably in excess of anything that will ever be realized. Of course it is impossible to calculate the stresses caused in a structure from earthquake and therefore to economically provide for them, but, as a guide in design, it was estimated that an inclination of 6° from the vertical should not strain the tower beyond the elastic limit. It is thought that this inclination is in excess of what may be caused by any probable earthquake in this locality, and such an inclination would only be of momentary duration if it occurred.

A number of pipe lines have been built at this plant for various mining companies, but the most important is the 42-in. pipe line which is a part of Manila's new water-works system. The dam for the new water supply is situated some 16 miles from Manila, and the pipe line, in conjunction with about five miles of concrete-lined

Fig. 2. Laying 42-in. Steel Pipe-Line for Manila Water Works.

tunnels, conveys the water by gravity to the reservoir a short distance outside the city limits. Altogether there is over 10 miles of this pipe. It is made of 3-16-in. plate with double riveted lap joints and is dipped in asphalt.

A part of the water-works line—that in the gorge, a length for about two miles from the dam—is laid through rough country and consequently is very crooked and difficult. Many concrete culverts are used to carry the pipe over small waterways, while in two places it is carried across ravines on steel bridges. All the bends were carefully figured and laid out in the shop to fit the survey. Except in special cases, the pipe was made in 35-ft. lengths, shipped by train to the nearest point, and thence hauled on special wagons along the work as required. Most of the pipe is buried about 4 ft. below the surface.

All the shop work, as well as the field erection, is carried on with Filipino laborers under the direction of white foremen, and perhaps the most interesting feature to one visiting this plant for the first time is to see how skillful America's

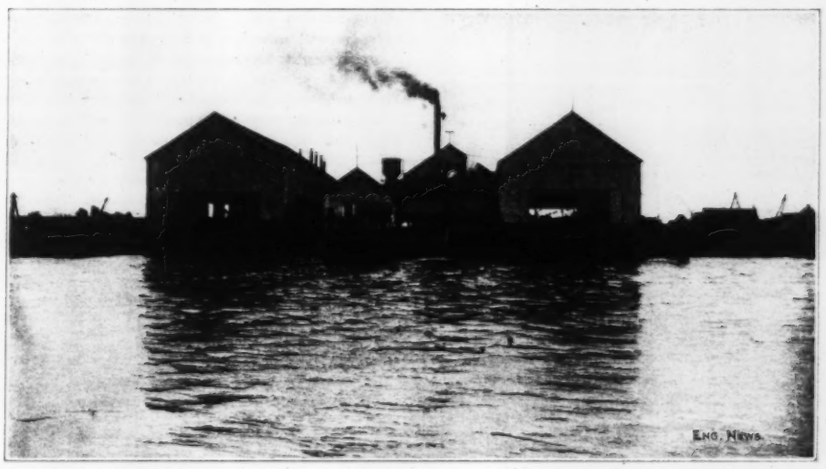


FIG. 1. THE FIRST STRUCTURAL STEEL WORKS IN THE PHILIPPINES.

*Manila, P. I.

FIG. 3. BRIDGE OVER PASIG RIVER.
Built by Atlantic, Gulf & Pacific Co.

"little brown brothers" are becoming. A foreman remarked one day that if you were to tell people back in the States that we were building bridges out here with people whose language even we could not speak, you would not be believed. As a matter of fact, there have been represented at the shops at one time 18 different dialects, so that not only has it been quite impossible for white men to talk directly with most of the natives, but it is difficult for the natives to make each other understand.

Fig. 4. Elevated Water Tank of 100,000 Gallons Capacity.
(Built in the Philippines by Atlantic, Gulf & Pacific Co.)

The school system which Americans have put into operation is already beginning to give results, and young boys who have learned English and have had a course in one of the trades schools, are proving themselves very efficient in the shop.

The natives learn quickly, and soon become quite expert at the one part of the work they are taught. One common "tao" who had never seen a machine in his life, was started with one of the gangs on a power riveter, and three months later drove, on an average, 2,900 rivets per day in riveted pipe. All the actual work of operating the machines and handling the material is done by natives. At no time have there been more than five or six white men connected with the plant.

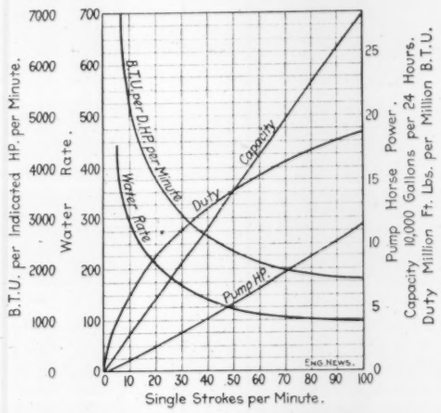
TEST OF A DIRECT-ACTING SIMPLEX BOILER-FEED PUMP.*

The data available on actual performance of the most common power plant auxiliary, the simple direct-acting steam pump, are mostly related to steam consumption per I. HP. at full rated loads, and comparatively few are found showing slip, heat and steam consumption, efficiency, etc., at variable loads or speeds. The data in the accompanying table and figure have been derived from a test on a 12 × 7¼ × 12-in. simplex pump at the Armour Institute of Technology. There was nothing unusual about the pump nor, indeed, are the figures extraordinary, except, perhaps, in that similar ones have not been widely circulated. The excessive power "consumption" at slow speed is especially noticeable. The pump had been in use for six years, but was overhauled and repacked for this test run, which was made in accordance with the code of the American Society of Mechanical Engineers.

*Data furnished by Professor G. F. Gebhardt, M. Am. Soc. M. E., Armour Institute of Technology.

SOME UNSOLVED PROBLEMS IN METAL MINING.

Unsolved problems in metal mining were discussed by Prof. Henry Louis before the Institution of Civil Engineers on April 27, as reported by the "Iron and Coal Trades Review"; the difficulties of boring, blasting and shaft sinking are perhaps as important to civil engineers as to the mining fraternity. After dwelling on the elasticity of the term "Ore," the waste dump of one generation being the valuable ore of a succeeding metallurgist owing to improvement of mill or smelter process, Prof. Louis pointed out the present narrow limits of means of identifying the locality of mineral ground: as a rule an outcrop must be found before farther exploratory work can be profitably undertaken; continuous metal beds, such as the zinc deposits near Joplin, Mo., are rare. In one exception only has science come to the prospector's aid—magnetic iron properties in Sweden are customarily valued and sold by their "compass drag," the effect of the ore-body on a vertically suspended magnetic needle above ground. In view of the widely different electric and magnetic properties of minerals, a fruitful field is here open for farther development of electrical experiments with the purpose of locating hidden metal. Such information as may be derived from geological evidence is, in the present state of that science, entirely inadequate to warrant any considerable expenditure on preliminary underground exploration. This branch of economic geology presents the most difficult problem of all and the one which is least approached by any solution.



Performance Curves of a Direct-Acting, Simplex Boiler-Feed Pump, Under Ordinary Working Conditions.

Boring is brought into requisition when the location of a deposit is already approximately known. The first subject presenting itself for investigation in this connection is the artificial production of "bort," the carbons set in the diamond drill with which deep borings are now univer-

TEST OF A 12 × 7¼ × 12-IN. SIMPLEX BOILER-FEED PUMP WITH STEAM ACTUATED VALVE GEAR, AT ARMOUR INSTITUTE OF TECHNOLOGY.

1	No. of single strokes per min.	5	9.2	13.7	20	28	41	48.6	61.2	72.2	8.2	100.6
2	Total head, feet of water	204	196	214	208	219	219	220	219	230	240	248
3	Water pumped, gal. per min.	10	18	25	38	54	78	93	117	139	158	194
4	Piston displacement, gal. per min.	10.05	18.05	26	40	56.5	81	96.5	122	145	165	201
5	Rated displacement, gal. per min.	11.72	20.45	29.7	44.9	62.75	86.75	103.6	130.5	154.2	174.2	209.4
6	Actual capacity; gal. per 24 hrs.	14,400	25,920	36,000	54,720	77,760	112,300	133,920	168,480	200,160	227,520	279,360
7	Steam pressure, gage	34	39	43	45	46	51	54	61	60	56	62
8	I.-HP. steam end	0.55	1	1.5	2.25	3.2	4.8	5.8	7.38	8.86	10.2	12.8
9	I.-HP. water end	0.51	0.95	1.4	2.1	2.95	4.45	5.35	6.85	8.26	9.55	12.5
10	Developed horse power (D. H. P.)	0.5	0.9	1.35	2.0	2.85	4.20	5.17	6.63	8.	9.15	11.45
11	Dry steam per hour	235	293	364	461	511	655	721	860	889	973	1,232
12	Dry steam per I.-HP.-hr.	424	293	243	205	159.5	136.3	124.3	116.5	109	95.5	96.3
13	B. T. U. per D. HP.-hr.	7,975	5,550	4,440	3,965	3,075	2,680	2,400	2,230	1,899	1,835	1,825
14	Mechanical Efficiency = I.-HP. water cyl. / I.-HP. steam cyl. =	0.921	0.95	0.933	0.933	0.923	0.927	0.922	0.927	0.932	0.936	0.948
15	Mechanical Efficiency = I.-HP. steam cyl. / D. HP. =	0.907	0.90	0.90	0.91	0.89	0.875	0.89	0.897	0.902	0.897	0.895
16	Per cent. slip (Line 4 — Line 3) / Line 4 × 100	0.497	0.278	3.85	5.00	4.42	3.7	3.63	4.1	4.12	4.24	3.48
17	Per cent. slip (Line 5 — Line 3) / Line 5 × 100*	14.65	11.97	15.81	15.35	13.95	10.10	10.25	10.35	9.86	9.30	7.37
18	Duty in million ft. lbs. per million B. T. U.	4.14	5.95	7.15	8.35	10.72	12.33	13.75	14.8	17.35	18.02	18.08

†Above ideal feed temperature.
*Since the stroke had been shortened to insure smooth running this apparent slip and "short-stroking" is greater than it would have been had the pump been operated as originally designed.

sally made. The cost of the comparatively rare black diamonds now used for this purpose is one of the system's large items of expense. The next difficulty with the rotary bore-hole is its usual deviation from the vertical or starting direction.

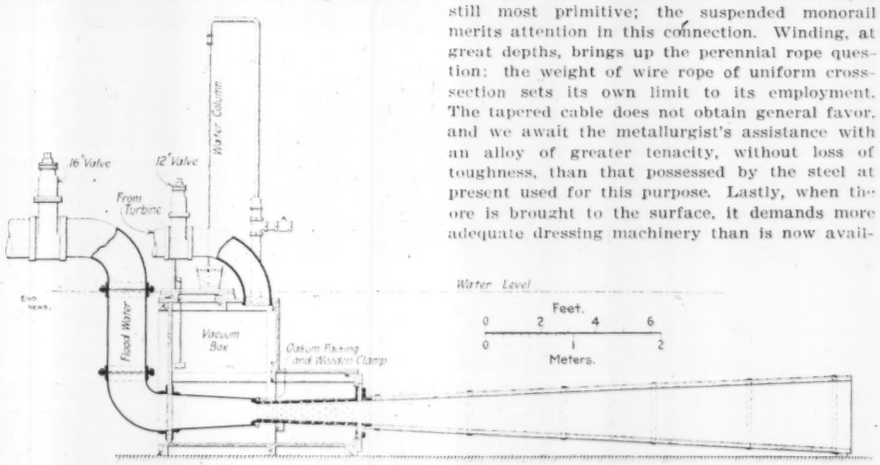


FIG. 1. CLEMENS HERSCHEL'S "FALL INCREASER," AS APPLIED TO A HYDRO-ELECTRIC POWER STATION.

as large a lateral development of position as 1 in 3 is common, and the determination of its bearing by present unsatisfactory methods depends upon the use of a magnetic needle subject to indeterminable electric and magnetic influences. Shaft sinking to any depth desirable from an economic point of view presents no insuperable difficulties to the modern engineer, concerned only with such minor questions as working speed and cost, comparative value of rectangular and circular form and the extension of the use of reinforced concrete lining. The detail of drilling, however, presents a problem of immediate importance. The boring of shot holes for sinking and driving commodious shafts and levels and breaking rock in large stopes has in 50 years made enormous advances, yet the pneumatic drill, the only form so far equal to the demands of a hard rock face, labors under the drawback of a loss of from 28 HP. at the compressor to 5 HP. in the drill cylinder and still farther to 1.7 HP. at the point of actual impact. Electricity has not been successfully adapted to the reciprocating action of the precussive drill; a rotating machine should prove the acceptable solution if a sufficiently hard and strong bit becomes commercially available. A light, compact drill that can be handled by one man in the confined spaces and awkward positions necessitated by the majority of mine working places, will bring huge reward to the successful inventor.

Underground haulage, except in the rare instances where a long, comparatively straight adit or level renders electric locomotives available, is still most primitive; the suspended monorail merits attention in this connection. Winding, at great depths, brings up the perennial rope question: the weight of wire rope of uniform cross-section sets its own limit to its employment. The tapered cable does not obtain general favor, and we await the metallurgist's assistance with an alloy of greater tenacity, without loss of toughness, than that possessed by the steel at present used for this purpose. Lastly, when the ore is brought to the surface, it demands more adequate dressing machinery than is now available. A crusher that will give a uniform product, 0.05 to 0.01 in. in diameter without a heavy burden of slimes, is one of the most important of the mechanical problems of metal mining.

A DEVICE TO INCREASE THE EFFECTIVE HEAD OF A WATER-POWER PLANT BY UTILIZING WASTE WATER.

In 1907, in connection with a competition of designs for a hydro-electric power station for the city of Geneva, Switzerland, Mr. Clemens Herschel, M. Am. Soc. C. E., 2 Wall St., New York City, invented a piece of apparatus termed a "fall increaser," designed to increase the effective head of turbine plants by the use of freshet water going to waste. The arrangement is shown in its essential parts by Fig. 1, from which it is seen that the throat of a Venturi-meter tube is perforated and enclosed in a tight box to which the turbine discharge-pipe is connected. It would be expected from the action of the Venturi meter that a suction pressure wou'd be created in the vacuum box and Mr. Herschel's experiments have shown that the suction could be maintained to a useful degree with a heavy turbine discharge by a reasonable amount of surplus water.

Fig. 1 shows the arrangement for testing the device at the Holyoke Testing Flume. During the course of experiments with a discharge through the 12-in. draft pipe, about 40% that through the 16-in. operating pipe a suction head of 14 ft. was easily maintained. With no discharge from the 12-in. pipe, the suction pressure rose to nearly 30 ft. and the sides of the suction box were crushed in. A long series of tests have been made on several throats of different dimensions and suction apertures. The results of such a series of tests on one throat are plotted in Fig. 2 and the terms employed on this diagram are outlined below.

$$\text{Efficiency} = \frac{\text{Work gained}}{\text{Normal head} \times \text{operating water.}}$$

This is derived as follows:

Let h = normal operating head.
h_1 = head gained by "fall increaser."
Q = turbine discharge under head (h).
Q_1 = turbine discharge under head ($h + h_1$).
Q_2 = operating water through "fall increaser" under head (h).

Work done without fall increaser = $Q\,h$.
Work done with fall increaser = $Q_1\,(h + h_1)$.
Work gained by fall increaser = $Q_1\,(h + h_1) - Q\,h$.
and as

$$\frac{Q}{Q_1} = \frac{\sqrt{h}}{\sqrt{h + h_1}} \quad \text{and} \quad Q = \frac{Q_1\sqrt{h}}{\sqrt{h + h_1}}$$

substituting above
Work gained by fall increaser =

$$Q_1(h + h_1) - \frac{Q_1\sqrt{h}\,h}{\sqrt{h + h_1}} = Q_1\left(\frac{\sqrt{(h + h_1)^3} - \sqrt{h^3}}{\sqrt{h + h_1}}\right) \quad (A)$$

$$\text{Efficiency} = \frac{(A)}{Q_2\,h}.$$

$$\text{Water Ratio} = \frac{Q_1}{Q_2}.$$

$$\text{Head Ratio} = \frac{h_1}{h}.$$

Fig. 2 shows a remarkable characteristic of the apparatus. The curves showing the relation between water ratio and efficiency in one instance and between water-ratio and efficiency in the other are the same for all values of operating water, from maximum to minimum, through the Venturi-tube throat.

As a general proposition, using the "fall increaser" to increase the effective head, where plenty of water was going to waste, it would be proposed to increase the head by 50%. Tests indicate that this could be reached with a water ratio of 0.42; that is, the operating water through the Venturi tube would be 2.38 times the turbine discharge under the increased head. If the head was increased 50%, the HP. for each gate opening would be increased about 80%.

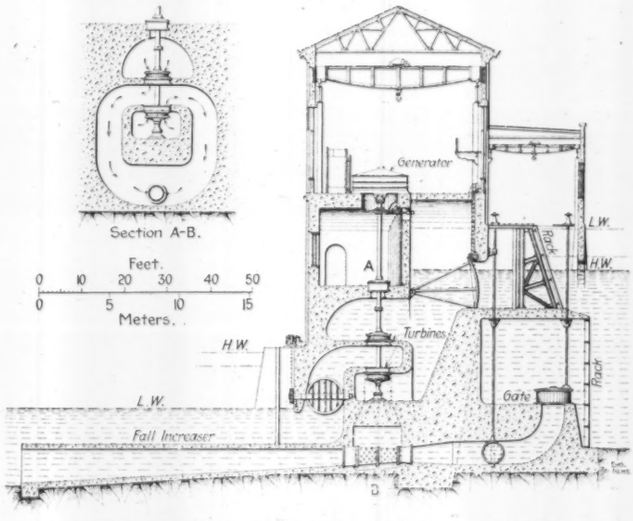


FIG. 2. EXPERIMENTAL ARRANGEMENT OF HERSCHEL'S "FALL INCREASER" AT THE HOLYOKE TESTING FLUME, HOLYOKE, MASS.

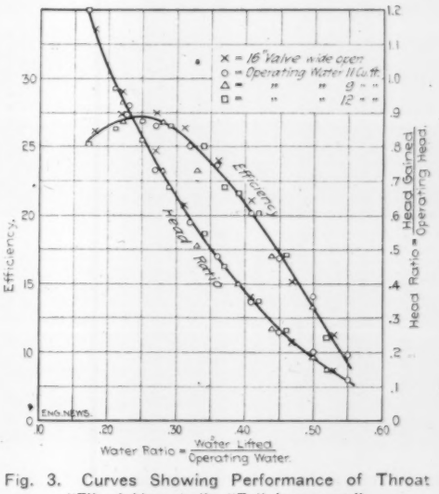

× = 16" Valve wide open
○ = Operating Water II Cult.
△ = " " 9 " "
□ = " " 12 " "
Efficiency
Head Ratio
Efficiency.
Head Gained / Normal Operating Head.
Water Ratio = Water Lifted / Operating Water.
ENG. NEWS.

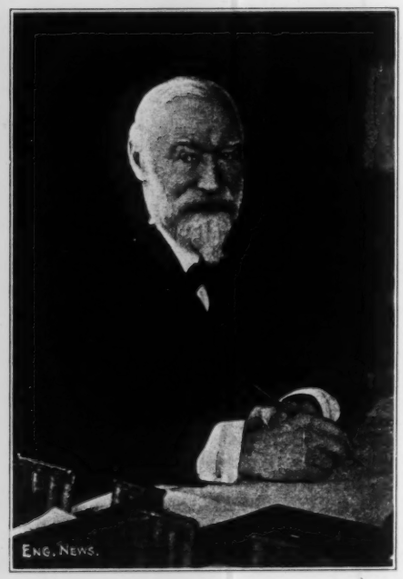
Fig. 3. Curves Showing Performance of Throat "F" of Herschel's "Fall Increaser."

THE DRAWBRIDGES crossing the Chicago Drainage Canal are at last to be equipped with operating machinery. It is stated that the work can be completed by April, 1910. The law required this to be done by December, 1906, and the time was later extended to December, 1908, but definite action in the matter has only been taken recently. There are 15 bridges to be equipped. Most of these are swing bridges. The big double-leaf eight-track bascule Scherzer bridge at Campbell Ave. will not be thus equipped, but will be replaced with a single-leaf bascule bridge. It was found on investigation that such an immense amount of cutting, drilling, riveting, altering and new material would be required to adapt the present bridge for operation, that it would be very much cheaper to put in a new bridge. The present structure was built in 1900. It was described and illustrated in our issue of May 24, 1900.

ALEXANDER MACKENZIE.

The retirement on May 25 of Brigadier-General Alexander Mackenzie from the position of Chief of Engineers has been noted in a previous issue of Engineering News. Gen. Mackenzie was born in Wisconsin, May 25, 1844, he entered West Point in 1860, and, graduating in 1864, was commissioned a first lieutenant in the Corps of Engineers. During the last two years of the Rebellion he served as Assistant Engineer in the Department of Arkansas, receiving March 13, 1865, the brevet rank of Captain "for gallant and meritorious services." After the war he was connected with the repairs of Fort Washington, Md., the examination of the Mississippi levees and the improvement of the harbors of Lake Michigan until 1867, when he was promoted to a Captaincy and was placed in command of a company at Willett's Point, N. Y. From 1874 to 1878 he was assistant engineer on the Louisville and Portland Canal and improvement of the Falls of the Ohio at Louisville, Ky., under the supervision of Major Weitzel. He was then transferred to the Upper Mississippi Valley, where the Des Moines Rapids Canal and locks were among the works under his care. In April, 1882, he was made a Major and for the next dozen years he was employed on works demanding a high quality of engineering judgment. He superintended improvements of the Mississippi River between Des Moines Rapids and the mouth of the Illinois River, and served on the Missouri River Commission and on various other river and harbor engineer boards. In July, 1895, he was promoted to the rank of Lieutenant-Colonel, and became first Assistant to the Chief of Engineers. He was made a Colonel in 1901 and served as a member of the Board of Engineers for Rivers and Harbors, member of the Provisional General Staff and of the General Council, was appointed to the General Staff Corps, and was a member of the Board of Government and Direction of the War College. He also aided in the work of the Board to determine upon a site for a central military post in the Island of Oahu, Hawaii Territory, and to conduct a military reconnoissance of the Hawaiian Archipelago.

His final promotion during active service was that to Brigadier-General and Chief of Engineers, Jan. 23, 1904. During the time that he commanded



Brigadier-General Alexander Mackenzie.

the Corps of Engineers and was in full charge of the engineer department, he also acted on the Boards of Ordnance and Fortification, of Commissioners of the Soldiers' Home, of the Board to revise the report of the Endicott Board appointed under the provisions of an Act of Congress approved March 3, 1905, to "examine and report at what ports fortifications or other defenses are most urgently required," and since March, 1907, was a member of the Inland Waterways Commission. May 25, 1908, he was placed on the retired list with the rank of Major-General, Corps of Engineers.

WILLIAM DANA EWART.

William Dana Ewart, the inventor of the malleable-iron detachable drive chain, exploited by the Link-Belt Machinery and Engineering Companies, died at Rome, Italy, May 3, at the age of 56 years. His invention has had an important influence in the development of elevating

William D. Ewart

and conveying machinery and agricultural machinery. The original invention was a sprocket chain link adapted to hook into the preceding and following links and yet not become detached while the chain was running.

Mr. Ewart retired from active business several years ago on account of failing health, and has resided in southern Europe since.

A COAL BRIQUETTE PLANT* built in 1907 at the Bankhead Mines, Alberta, Cana, has so successfully solved the problem of waste presented by the large percentage of dust which is produced on account of the exceptionally friable constitution of the mine output, that the original unit of which the plant at first consisted is now being doubled. The method followed is known as the "Zwoyer" process, and operations are carried on under license from the Zwoyer Fuel Co., of New York City. The dust instead of being dumped on the waste pile is now passed to the dust bin in the breaker. This bin is 20 × 30 ft. and 24 ft. deep, and adjoins the machinery house which, 60 × 73 ft. in area, contains the briquette machinery, crusher, mixer of six units, pitch storage-tank, 12 × 6 × 8 ft., double cylinder engine, 14 × 20-in. stroke, two dust elevators and briquette press. A cooling house contains the cooling table and machinery for driving the briquette conveyor.

The dust is carried from the bins to the crusher by a drag-chain, passes to the mixers and is there heated by the gases from the mixer furnace while pitch is introduced by an atomizer. From the last mixer it is brought by an elevator to the press and briquetted. By means of a belt-conveyor the briquettes reach the distributor over the cooling table and after being carried back and forth over the latter 7¾ times, the briquette conveyor finally deposits them in the briquette bins. The briquettes are sold for $4.00 per ton at the plant and find ready demand, one division of the Canadian Pacific using them exclusively as fuel. The total output for 1907 was 43,703 tons; it is expected that the enlarged plant will produce 15,000 to 16,000 tons of briquettes per month.

*Discussed at the Feb. meeting of the Am. Inst. M. E. by E. W. Parker, Washington, D. C.

THE DEPOSITION OF ARSENIC FROM SMELTER FUMES AND CONSEQUENT POISONING OF VEGETATION.

The effects of smelter smoke in Montana have been studied by Messrs. R. E. Swain and W. D. Harkins, who give the results and details of numerous analyses in the June issue of the "Journal of the American Chemical Society." That the topic is a pregnant one is attested by the numerous lawsuits which still hang over some of the most important metallurgical centers of this as well as other countries. The work of the gentlemen mentioned is based on examinations of the vegetation of Deer Lodge Valley and adjacent territory, consisting in main part of a broad basin 35 miles long and 6 miles wide at whose head, a thousand feet above the valley floor, the smoke-stream from the Anaconda smelter leaves the stack and may be traced as far as the eye can reach, trailing for 30 miles with the wind.

The primary incentive to the investigation was apparent arsenical poisoning of livestock, attributed by the ranchmen to deposition of metallic salts from the fumes of the reduction plant. Samples of hay and wild grasses were collected from various parts of the region, carefully localized in regard to prevailing wind direction; the season of the year at which they were taken was also noted. The importance of such specialization is readily seen from the difference between results obtained from vegetation which has been exposed to the chemical agents for varying lengths of time, owing either to the more frequent passage of the smoke conveying wind along certain paths than along others, or to the differing age of the grasses, cut in approximately the same spot but at different stages of maturity. This duration of exposure was found to be the determining factor of arsenic content. The following table shows the amounts of arsenic and copper contained in the vegetable tissue of a number of samples selected from the chemists' list at random; H denotes hay taken from stack, G, grass cut in field, L, leaves of trees.

Sample.	Month.	Distance.	Parts per million.* As_2O_3	Cu.
G	Nov.	0.25 mi.	1,551	1,800
H	Nov.	1.50	283	...
H	Nov.	3.00	36	216
G	Oct.	4.00	10	128
L	Jan.	5.	100	563
L	Sept.	0.5	427	...
H	Feb.	5.	50	46

*Parts per million are equivalent to ten thousandths of 1%, and multiplied by 0.7 = grains in 100 lbs.

The British Royal Commission on Arsenical Poisoning recommended that penalties be imposed upon any vender of liquid food which carries 1/100 grain or more of arsenic in the gallon or of solid food containing 1/100 grain per pound. Deductions from this principle and preceding table are necessarily invidious.

To controvert a possible claim that the deleterious ingredients may have been absorbed by the vegetation from the soil, plants were set out in regions removed from the action of the fumes but in soil gathered near the smelter: in no case did plants thus matured show more than 0.0002% of arsenic trioxide, although grass grown at the original site gave values as high as 0.263%. Equally conclusive data were obtained from the organs of animals which had succumbed presumably to the effects of their diet in or near Deer Lodge Valley. A single instance, giving rather lower results than the average, is the following:

Organ.	As_2O_3 in parts per million.
Ulcer in nose	658
Stomach contents (dried)	398
Urine	59
Liver	6
Stomach	4.7
Heart	2.1
Bones	2.2
Average of 10 samples of milk from several cows	2.

General symptoms of chronic arsenical poisoning in all stages were found well defined among the stock feeding in the smelter regions.

The results of these investigations are of interest to the industrial chemist as well as to the metallurgist; the removal and profitable disposition of the valuable and, when uncontrolled most harmful, products of chimney gases offers a problem whose solution should be attempted by extensive experiments.

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In connection with the block signal system in the Brooklyn tunnel extension of the New York Subway System, as described in another part of this issue, there is shown an indicator in the form of an illuminated chart on which the despatcher, in control of this section, sees the position of all trains in his territory. This is, we believe, the first realization of a dream of numberless inventors and a study of the present installation suggests its limited application. Contrary to the probable expectation of all these inventors, the success of such a device, under such conditions as are outlined in this article, does not insure its success in railroading generally as a preventive of all the despatcher's troubles. Indeed, the real necessity of such an indicating system as this, for a surface railroad, may reasonably be questioned if this particular operating company has found it desirable for a tunnel section alone. It should be noted that the blocks approaching the tunnel on the Manhattan side and in the further Brooklyn extension are not connected to this or to similar indicators. Indeed, it appears as though the real service of the device was as a part of an extensive system for protecting passengers in case of accident rather than as a preventive of actual trouble.

Even in a case where the desirability of indicating at one point the position of all trains, on long stretches of track, has been established there is one limitation that attracts especial attention. From the article mentioned it is seen that each block served requires one wire of a separate signal circuit running to the despatcher's station. It is at once apparent that the number of long circuits becomes great, that their installation and repair becomes expensive and that their reliability is most uncertain in times of greatest need until for a busy 300-mile division objections overbalance any real or fancied utility.

The State of New York *may* make a beginning in the work of flood prevention by reservoir construction. A law has just been passed appropriating $25,000 to make surveys and estimates for constructing a storage reservoir at Portage, on the upper Genesee River. We say *may* make a beginning, for the project is a very old one. It has been examined and reexamined by the state's own engineers and has been urged upon public attention again and again for many years as the best possible plan for preventing the flood damage at Rochester which frequently occurs.

So far as topographical conditions are concerned, few locations could be more favorable for carrying out the reservoir system; but in actually carrying out any such great work a vast amount of opposition has to be encountered and overcome, and the method adopted for financing the work is as important as the location chosen for construction.

In New York at the present time, the law contemplates that any such work of flood prevention shall be carried out on the system of appraisal for damages and assessment for benefits. That is to say, some body will have to assess the $10,000,000 more or less which the Genesee storage system may cost, on the various parties and interests which will receive benefit through abatement of floods or creation of water power.

Such a system may be successfully used for the work of levee construction, but to attempt to build great storage reservoirs by any such scheme borders on the absurd. Any such system would be certain to break down of its own weight. It could hardly secure the sanction of the legislature, and even if that were secured endless litigation in the courts would be certain to prevent its ever reaching realization.

Until the public realizes that the importance of flood prevention justifies radical measures for carrying it out by the direct action of the states or the nation, no real progress will be made toward the control of our waterways.

It is anything but reassuring to learn, from the report on a recent fire inspection, that of the public school-buildings in New York City no less than thirteen are in a dangerous condition with regard to fire, and should be closed immediately. This report, be it noted, is not the work of idealists, or enthusiasts striving for extreme degrees of safety. The inspection was carried out by the battalion chiefs of the Fire Department, each of whom was directed to examine all the schools in his division; these men are practical if they are anything, in fire matters, having the knowledge that comes from long service in actually fighting fires and handling panic-stricken human beings struggling to escape from flames. We must therefore take at full value the implication borne by their brief reports, that thirteen schools have such defects as to make them unsafe against fire. Incidentally the reports also show that over 90% of the remaining school-buildings have minor defects which should be remedied.

When a single city has even one school-building that endangers the lives of its occupants, the state of affairs is bad enough, but when the firetraps are multiplied to thirteen the matter is more serious than the lightest conscience can tolerate. It is easy, of course, to deprecate the importance of the condition as regards New York City, by pointing to the immense population of the city and to the large number of its school-buildings, over half a thousand. One may say: "Only one imperfect school for 250,000 inhabitants is not so bad. That is the same as when among ten cities of 25,000 there is only a single defective school-building! When the small towns and cities reach the same high stage of perfection the country may be congratulated. The cry of alarm should be directed against the small cities, not against New York."

But that is exactly why the present report is alarming. If safe public buildings are to be expected anywhere, it is in the very large city, where public sentiment, large money resources, and every advantage of highly-developed administrative organization favor the work. Such a community cannot show the slightest excuse for failure to make every school-building fireproof to the highest measure of technical skill. For years New York City has maintained a special department charged with designing school-buildings and supervising their construction. Should the ability and accumulated experience of such a bureau not afford a guarantee against the erection or continuance of dangerous structures?

We have in the past made a special argument of the fact that the cause of fire-protection of public buildings is most backward in the small communities, where absence of building laws, absence of the special public sentiment, lack of money, and lack of knowledge on the part of school-boards and the like make it practically impossible to secure other than indifferent results. All this is just as true to-day, and strictly true. The horrors at Boyertown and Collinwood afford recent illustrations of the dangers suffered to exist in such localities. But these conditions being due to very natural and for the moment unavoidable causes, are to that extent excusable. On the other hand, where everything is favorable to proper construction, there is no such excuse, and the existence of unsafe schools must call forth unqualified condemnation. It constitutes a grave indictment of the authorities charged with the care of the schools.

It is a mere coincidence that only a few weeks ago we had occasion to criticise the New York Board of Education for its ridiculous advocacy of "burning ashes." Our present argument is, of course, a matter wholly independent of this, except as both seem to indicate that the Board falls short of attaining the degree of efficiency to be expected from it.

Yet the indictment is not alone of the Board of Education, for public authorities always reflect more or less clearly the average sentiment (or apathy) of the public. If the average citizen were alive to the need for building schools thoroughly fireproof, it is all but certain that they would be so built. But the average citizen is very largely non-thinking or uninformed in this matter, and he is inclined to take more interest in attractive appearance than safe construction, when a school-building is concerned. The public, therefore, must bear part of the blame.

Many persons, perhaps unconsciously, regard schools as being largely exempt from fire. Only a short time ago we heard a well-educated, intelligent citizen say, in discussing a proposition for a fireproof school-building: "School-buildings never burn. Fires in schools are so rare that it is entirely unnecessary to spend a great deal of money providing for the remote contingency." And so he argued for the cheaper non-fireproof design.

As a matter of fact, the case is on the very opposite footing. Insurance experience gives the safest index of the actual risk, and school-buildings have proven a *losing venture* for fire-insurance companies, it seems. A large fire-insurance company of highly conservative character in a recent report covering only *protected* schools [that is such as have the benefit of fire-department service], makes the statement:

> This class of business has been a losing one for this company, and probably for all companies.

The fact stated is not due to excessively low rates, but to the high rate of losses.

The list of causes of school fires given in connection with this report is sufficiently various to withdraw the last support from the idea that schools are less exposed to fire danger than other structures. The classification of nearly 200 fires on which claims were made in a period of about twelve years is tabulated on the next page.

The advocate of cheap construction for school-houses, contemplating this list, can find little comfort in the thought "This or the other cause will not affect our building." No one or two causes deducted from the list will reduce the total sufficiently to change the general aspect of the matter.

School-houses are only very slowly coming to be recognized as proper subjects for the application of fireproof construction. The number of schools which embody any serious attempt to employ modern resources in the direction of fire-preventive construction form a vanishingly small part of the total. This fact is less surprising,

FIRES IN BRICK AND FRAME PROTECTED SCHOOL BUILDINGS AND CONTENTS.
January, 1896, to April 16, 1908.

Cause.	Number of Fires.
Heating	72
Heating apparatus	6
Defective flues	16
Stoves	4
Coal-gas explosion	2
Fire-places, open grates	1
Steam	1
Oil stoves	2
Hot-air furnaces	26
Wood partition near boiler	1
Sparks on roof	12
Coal in cellar	1
Lighting	13
Gas jets	2
Kerosene lamp	1
Electric lighting	9
Leaking gas-pipe	1
Carelessness	20
Adults	2
Children	4
Matches	5
Plumbers, mechanics, etc.	5
Janitor	1
Boys smoking	3
Incendiary	8
Lightning	49
Miscellaneous causes	21
Outside causes, exposures, etc.	6
Chemicals in laboratory	1
Burning out soil closet	1
Mice and matches	2
Balloon on roof	1
Closet fire	1
Spontaneous combustion	9
Conflagration	4
Unknown	5
Total	192

perhaps, when we couple it with such optimistic views as the one above quoted, that "school-buildings never burn." Undoubtedly, if such views are widely prevalent, as we believe they are, they are a prime factor in causing the backwardness of fireproof construction in the field of school-buildings. But in any event this condition must be changed. The promiscuous erection of school-houses of wood and with wooden halls and staircases, though adorned with a reassuring brick facade and impressive stone portico, must be brought to an end. Engineers, more familiar with the facts and needs of the case than other citizens, have the best opportunity to lead public sentiment in this direction.

THE RESERVOIR SYSTEM FOR CONTROL OF THE OHIO RIVER.

The project for a system of storage reservoirs in the Ohio River basin to control floods, benefit navigation and develop water power, is receiving much attention in the newspaper press. The paper on this subject by Mr. M. O. Leighton, Chief Hydrographer of the U. S. Geological Survey, in our issue of May 7, presented the project to the engineering profession for its consideration. In the present issue we publish three papers which further discuss the project and will still further concentrate the attention of engineers on this great enterprise.

In the first of these papers, the reservoir project is subjected to searching criticism by Capt. W. D. Connor, Corps of Engineers. In the second, Mr. Leighton replies to Capt. Connor's criticisms, and in the third, Mr. Horton, of the Geological Survey, discusses the effect of the proposed Ohio River conservation on floods in the lower Mississippi. This last paper, recalls the valuable series of contributions to Engineering News some ten years ago by the late Major Wm. Starling, M. Am. Soc. C. E., on the Floods of the Mississippi, which were afterward reprinted separately.*

Mr. Horton points out, as did Major Starling, that the floods in the Lower Mississippi come chiefly from the Ohio River, and draws the conclusion that a conserved Ohio River would be of benefit in reducing the flood heights on the Lower Mississippi.

There can be no doubt that this would be the case; but we think it well to emphasize, and strongly emphasize, that the control of the Ohio by reservoirs would not obviate the necessity of maintaining and strengthening the levees on the Lower Mississippi from Cairo to the Gulf. As we pointed out in connection with Mr. Leighton's original paper,—what his proposed reservoir system would do would be to hold back *the top of the flood wave only.* The Ohio would still flow bank-full during periods of high water. But as Mr. Horton's own figures show, the Ohio contributes only 31% on the average, of the Mississippi's outflow, while streams entering below the mouth of the Missouri, other than the Ohio, contribute 37%. The flow from the Missouri and upper Mississippi is seldom important as a contribution to flood volumes, but the flow from these other streams often causes high water in the Mississippi even when the Ohio is not in flood.

The reservoir system for the Ohio River, therefore, would not do away with the necessity of levees to protect bottom lands along the lower Mississippi; and as Mr. Leighton clearly points out in this issue, it would still leave necessary considerable work in dam and lock construction on the Ohio and its tributaries to increase the channel depth for navigation during the low water period.

But, the objector may say, if we must have levees and dams and locks anyway, why not do the whole work of river control by these means and dispense with reservoirs entirely?

It is a fair question and deserves an explicit answer. The reason is because (admitting the data on which the argument for reservoirs is founded to be correct) the river can be controlled more economically and beneficially by combining the reservoir system with the levee system than by either alone. Each is needed to supplement the other.

We must have levees in the lower Mississippi, for example, or there would be overflows every season. But until the levees are raised to a much higher level, there is always the possible contingency that an Ohio River flood may coincide with floods from two or three other great tributaries, and pour a volume of water into the lower Mississippi great enough to exceed all recorded flood heights, and overtop the levees.

Again, the cost of the levees increases rapidly as their height increases, and the destruction done by a crevasse through them increases in still greater proportion. The closing of the great basins by the extension of the levee system confines to the channel a body of water which was formerly free to spread over a territory many miles in width and further increases the flood heights. Altogether, if, by reservoiring the Ohio, we can avoid raising the height of levees, increase the safety of lives and property behind them, and simplify the problems of bank protection and channel revetment, it will go far to justify the reservoir system.

We believe further that Mr. Leighton is absolutely correct in placing flood protection as the first and chiefest purpose of the reservoir system and the benefit to navigation as secondary. Year by year the damage done by floods mounts higher and higher. The cities on our great rivers can get along if necessary with such navigation conditions as at present exists; but the damage done by the floods is too serious to be permanently endured.

Nor is this all. Indications point strongly to the fact that flood conditions are rapidly growing more serious. The cutting off of the forests on the remote mountain slopes has only become possible with the high price of lumber that has prevailed for ten years past. A vast volume of testimony can be gathered furnishing proof that the floods are growing more severe on the one hand and that the run-off in the dry seasons shrinks smaller and smaller. Even as we write, the newspaper dispatches are full of reports of serious floods in Oklahoma, Texas, Kansas, Arkansas, Missouri, Minnesota and Montana, where the rivers have risen to heights never before recorded, destroying millions of dollars worth of property in roads, railways, bridges and crops. At Pittsburg, two floods breaking all records for height and amount of destruction occurred in 1907 and another occurred in the spring of the present year.

If, then, at a cost not too great for construction work and land damages, a system of reservoirs can be made to supplement the protection furnished by dikes and levees, to help the navigation conditions as well, and to furnish also a revenue through the development of water power, it is surely worth careful consideration at least.

In the study which we have given to the reservoir system, it has seemed to us that the wisest course would be to test its possibilities first by investigation of a part of the system proposed. If the reservoir system can be made a practical success for any part of the Ohio River, it is on the Allegheny and Monongahela rivers which join to form the Ohio. Topographical and geological conditions for economical reservoir construction would be as favorable certainly as anywhere in the Ohio basin, while the benefits to be gained are greater than for an equal amount of work anywhere else. The cities of Pittsburg and Allegheny have a greater stake in flood prevention than any other cities in the country. The losses in these two cities by the great flood of 1907 are said to have reached some $12,000,000.

Further than this, the great industrial center at this point has an interest in *the maintenance of the low water flow* in the Allegheny and Monongahela, that has nowhere received attention. As our readers know, Pittsburg draws its water supply from the Allegheny River, and while it has just installed a huge filter plant to purify this water, it is highly desirable that the water in the river be in reasonably good condition before filtration. At low water stages, the river is bound to be more polluted and to carry a much larger percentage of lime salts than at ordinary stages.

Again, the Monongahela River at Pittsburg during periods of extreme low water has been aptly likened to a huge reeking cesspool. Col. Thos. P. Roberts, in a paper read April 21 before the Engineers' Society of Western Pennsylvania stated that the amount of free sulphuric and muriatic acid in the Monongahela during low water periods is sometimes as much as 10 grains per gallon. The low water flow at Dam No. 1, below the mouth of the Youghiogheny, he found in the drought of 1895 to be only 166 cu. ft. per sec., and he estimates that in dry weather the evaporation alone from the pools on the Monongahela amounts to more than 100 cu. ft. per second. The height of the pools is only maintained during the dry season by calking the flashboards on top of the dams with straw and ashes and drawing from the higher pools. In the vicinity of Pittsburg, considerably more than twice the estimated low water discharge of the river is daily pumped from the river and returned to it after having condensed steam and cooled furnaces. In midwinter, when the ice on the upper river was 5 ins. thick, the surface temperature of Pool No. 1 was measured at 75 points in midstream and ranged from 45° to 90°. What the temperature is in midsummer is not stated, but can be readily imagined, as can also the condition of foulness of the river, receiving as it does the sewage discharge of the dense population all along its banks.

As Col. Roberts well says, it needs only a prolonged period of low water to arouse Pittsburg to a much greater interest in the serious pollution of the river. Col. Roberts himself suggests that the water supply in low water could be augmented "by building several auxiliary dams on the Cheat or West Fork rivers to hold water in reserve."

Reference to the table of Monongahela River reservoir sites in Mr. Leighton's paper in our issue of May 7, p. 500, shows a total amount of water that could be stored amounting to 175 billion cu. ft. It can be readily computed that the stored water in the reservoirs would furnish through a drought lasting 100 days a daily flow of 1,750 million cu. ft., or *one hundred and sixteen times* the present low water discharge reported by Col. Roberts.

What such a change would mean to the industrial communities which are now dependent on the Monongahela River for a supply for various manufacturing purposes as well as for sewage disposal can readily be understood. Even if the whole system of reservoirs were not carried out, it would appear vitally important to the Pitts-

*The Floods of the Mississippi River, by Major Wm. Starling; paper; 7 × 10 ins.; pp. 57. Price, 10 cts., the Engineering News Pub. Co.

burg district that some one or more reservoirs be built on both the Allegheny and the Monongahela to increase the low water flow of these streams.

Regarding the value of the water power created by reservoirs, on which Capt. Connor casts doubt, it is, of course, true that the value of a water power depends on the market for it. The proposed Allegheny and Monongahela reservoirs, however, would create water powers in a district where little or no water power is now available and where electric current is used in enormous quantities. The water power to be created by these reservoirs, therefore, would all be marketable at a fair price and should go far toward paying the entire cost of the work.

Having in view all these conditions, it would seem well worth while to take the next step in testing the feasibility of the reservoir system by making a detailed survey and estimate for reservoirs in the Allegheny and Monongahela basins. The reservoir sites in these basins enumerated by Mr. Leighton in our issue of May 7, number 31, but the bulk of the storage is contained in 10 reservoirs. Doubtless detailed surveys would show that some sites were much more desirable than others; some of the sites proposed might prove uneconomical on detailed examination and other sites not now suggested might very likely be discovered.

Certainly if detailed surveys and estimates to test the feasibility of the reservoir system are to be made, it would be much more economical and expeditious to examine first the 19,000 sq. miles in the Allegheny and Monongahela basins before undertaking the survey and exploration for reservoir sites of the whole 150,000 sq. miles and over included in the Ohio River basin.

It is, of course, true that if surveys showed a reservoir system to be practicable and advisable on the Allegheny and Monongahela, it would not necessarily follow that the reservoir system would be advisable on all other tributaries of the Ohio. On the other hand, the place to start any great work and test its advantages is where it is most needed. If the reservoir system of river control can be made practicable anywhere in the Ohio River basin, it is on the rivers which meet at Pittsburg. Here, then, is the place to make the first test—or, rather, the preliminary examination to determine whether an actual test is advisable.

And now the question comes, who could make such an examination and carry out such a work? We see absolutely no escape from the proposition that if the reservoir system of river control is to be carried out, it must be by the Federal Government, as Capt. Connor states in his paper in this issue.

Bear in mind that in order to create any such system of reservoirs the power of eminent domain must be exercised on a great scale. The cities of Allegheny and Pittsburg if they desired to undertake the work would have to secure authority not only from the State of Pennsylvania but from the legislatures of New York, West Virginia and Maryland.

Suppose—what is almost unsupposable—that the legislatures of these states would grant the necessary statutory powers. What would then happen would be that some objecting property-owner would appeal to the courts; and, judging by past judicial decisions, the courts would rule that a state could not condemn property of its citizens for the benefit of another state.

Several distinguished public men have recently been opposing Federal action for the Appalachian forest preserve and arguing that states ought to cooperate with each other, make compacts for carrying out works in which they are mutually interested, and as Speaker Cannon said in Washington recently, "form confederations." But if such a policy were actually adopted and put in force, exactly the same impassable barrier which we have pointed out above would be reached. Even if the state of New York were willing to make a contract to flood farms and villages in its territory in order to benefit cities in Pennsylvania, she could not carry out its terms.

This very question came up for consideration nearly ten years ago, when the additional water supply for New York City was under examination and the nearest source of supply was found to be the Housatonic River in Connecticut. An able committee of lawyers considered the question whether, if the Connecticut legislature were induced to pass an act enabling New York to take this water, it would be upheld by the courts. The committee, after studying the court decisions, advised against the taking of any water supply from beyond the state boundaries because of the legal difficulties certain to arise.*

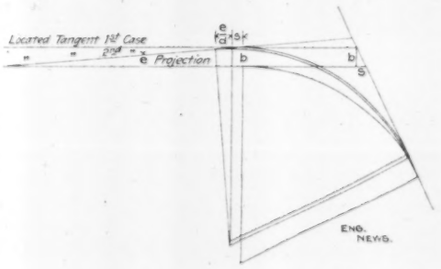
In conclusion, one point raised by Capt. Connor deserves a special word of mention. That is the possibility that the reservoirs proposed would be rapidly filled up with material deposited by inflowing streams. The answer to this question depends on our future public policy respecting forest preservation and soil erosion on mountain slopes. Certainly if we continue in the course we have begun, the task of river control by any means within the power of the engineer bids fair to become impossible because of the heavy burden of silt and detritus. If the reservoirs are not built it will choke the river channels. Surely, then, the engineering profession, and all the members of it in any way interested in the great problems of river control, ought to use all the influence at their command to induce action—and prompt action—by both Federal and state Governments to protect from destruction the remaining forest cover on the mountain slopes.

LETTERS TO THE EDITOR.

Method of Running Curves from Paper Location.

Sir: I have made considerable railway location during the past two years in a country with steep slopes, requiring frequent curves of small radius, and find that the following methods have given best results in putting our paper location on the ground.

The preliminary map is drawn to a scale of 200 ft. to the inch, using a meridian and a B. & S. protractor, reading to five minutes, platting the courses directly. In finding the courses for the location tangents, the departure from the governing preliminary course is ob-



Curve Laid Out With Parallel Tangent.
(As shown in the figure the angle is added and P. C. backed up; for the opposite case, angle is subtracted and P. C. thrown ahead.)

tained with the protractor, and the central angle of the curve is calculated. In this manner the located tangent at least lies parallel to the projection, even though the preliminary has been platted incorrectly; subsequent shifting is also easier. As we seldom run our tangents to intersection and our location is made with a view to revision, we make the shift from the P. C. before running the curve around, by the formula $S = D.\ cot.\ \Delta$, see Fig. 1, provided the located tangent is parallel to the projection. If the tangent should not be parallel to the projection, after obtaining the angle of departure by means of ties to the preliminary, this angle is added to or subtracted from the central angle, and the length of arc for the angle of departure added to the shift obtained as above stated, so that if tangent were turned at the point which the shift gave calculated as the parallel, tangent so obtained would be parallel to the projection and the tangent ahead will lie approximately on the ground desired.

Yours very truly,
J. W. Moore,
Locating Engr., Carolina, Clinchfield & Ohio Ry.
Bruce, Va., May 13, 1908.

*"The Water Supply of the City of New York," published by the Merchants' Association of New York, 1900; pp. 456, 459.

The Removal of Suspended Matters from Water and Sewage and the Removal of Bacteria from Air for Enumeration.

Sir: I was much interested in your editorial of March 26, 1908, entitled "The Removal of Suspended Matters from Water and Sewage." Of course all who have thought seriously about the matter have realized that the action of water and sewage filters scarcely deserves the name of filtration. The treatment of sewage, for example, on trickling beds of coarse stone reduces the

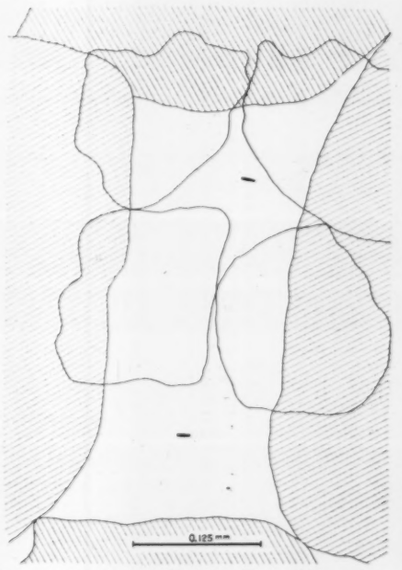


Diagram Showing the Relative Size of Bacteria and Filter-Sand Grains.

idea of "filter" to an absurdity. I have never, however, seen so clear a statement of the question as yours, and your alternative term "adhesion" to express what goes on in a filter appeals to me as particularly suggestive. It deserves to be adopted for all discussions of such subjects.

I have been particularly interested in this problem of late because I have been engaged for about a year in a study of the bacterial content of the air in sewers and drain pipes under various conditions. Major Horrocks' important paper on this subject, published in the Proceedings of the Royal Society a year ago, has reopened the whole question of the possible danger of bacterial infection of sewer air and made a careful revision of methods essential. By testing the ordinary sand-filter method used for air analysis, in comparison with a method which seems to me unquestionably accurate, I have convinced myself that the sand method is fairly accurate, provided it is properly applied. If the sand used for filtering bacteria out of the air has a diameter over .5 mm. a large proportion of the bacteria pass, but if the sand is less than .3 mm. results are good. Under these conditions, where air is drawn through dry and clean sand, there can of course be no question of filtration proper. The size of the sand grain used in my investigation is shown in relation to one of the largest of bacteria, B. megatherium, in the accompanying illustration. The largest shaded areas represent sand with a diameter between .5 and .1 mm., the space between being drawn to scale under the microscope. The smaller areas are drawn in the same way from four sand grains with a diameter between .1 and .3 mm. Two elongated dots show the size of the large bacillus.

A glance at the diagrams is sufficient to show that the bacteria are not removed in such a filter by "filtration." Adhesion is the only phenomenon which can account for the observed fact that the bacteria are actually removed. The size of the sand must of course affect the removal of fine particles in two ways: (1) in a given depth the number of surface contacts which permit adhesion must vary inversely with the size of the particles; (2) velocity of flow, which tends to tear off adhering particles, must under given conditions, increase with the size of the particles.

C.-E. A. Winslow.
Biologist-in-Charge Sanitary Research Laboratory, Massachusetts Institute of Technology.
Boston, Mass., April 23, 1908.

Confusion of the Terms "Asphalt" and "Pitch" in Specifications.

Sir: Any one who has had frequent occasion to read specifications for roofing or waterproofing has probably noticed the indefinite way in which the terms

"asphalt" and "pitch" are often used. Sometimes they are assumed to mean one and the same thing, sometimes they are regarded as alternates and sometimes asphalt will be mentioned where the context and general practice clearly indicate that coal tar pitch is meant. And this is found not only in specifications for unimportant work, prepared by men of limited experience, but occurs in the case of engineers, architects and contractors of wide reputation, engaged on large and costly undertakings. Indeed, among those who have not given this detail careful attention, the word "asphalt" seems often to carry a sort of glamor that results in its use where any material of this character is to be specified.

As a matter of fact the general term is "pitch," and it includes all substances of that nature from whatever source, the dictionary definition of asphalt being "mineral pitch." Therefore, while all asphalt may be called pitch, all pitch cannot be termed asphalt. Of the kinds of asphalt pitch, or more briefly, asphalt, that can be used for waterproofing, there are barely four or five out of fifty or more varieties that are in any respect suitable for such purposes. Of the other kinds of pitch there is only one, coal tar pitch, that can be considered for such work.

As between the two, engineers who have taken the time to investigate their relative waterproofing qualities are practically of one opinion, that coal tar pitch is at least as good as any asphalt. Evidence as to the correctness of this statement is being constantly furnished from old buildings where coal tar pitch has been in use twenty and thirty years and yet is chemically, mechanically and in every other respect, in exactly the same condition as when first applied.

When asphalt is specified in the lax manner above described, the chances are much in favor of coal tar pitch being used, as few inspectors are capable of distinguishing between the two, and coal tar pitch is from 25 to 50% cheaper. Bidders who estimate in good faith on the use of asphalt find their figures too high for consideration, and to get the work must either get the specifications relaxed or if less scrupulous, use coal tar pitch anyway, a practice that cannot well be defended.

In either case injustice is done to the reputation of coal tar pitch, as it must bear the reproach of being "something just as good" or else travel under a false name and miss the credit of its own good performance. It would be far better from both an ethical and engineering point of view if accurate terms of specification were arrived at in the first place, and used with a proper understanding of their meaning. If asphalt is required, it should be specified by brand or place of origin, and if coal tar pitch is desired, it should be plainly specified as such.

C. G. Atwater,
M. Am. Soc. M. E.

17 Battery Place, New York City, May 20, 1908.

Laying Out Turnout Curves.

Sir: The enclosed diagrams show some properties of turnouts which the writer has never seen in any textbook. They deal directly with the center line of the turnout and involve only such formulas as are used by every transitman in ordinary curve work.

The sub-tangent of the arc of the turnout from the point of switch to the point of frog is equal to half of the lead ($A\ I = \frac{1}{2}\ C\ B$). The curves of the main track and turnout have this same length (½ lead from same frog in straight track) as the sub-tangent, between point of switch and point of frog, when the track is curved, and there is a common *P. I.* for the main track and turnout.

The proof of $\tan \frac{\theta}{2} = \frac{g\,n}{R}$ is very simple compared to that in some text books. In fact it is not needed, for the problem is simply this: Given sub-tangent and radius, to find central angle and put in curve. Radius of turnout for same sub-tangent is readily determined. The tangent for compounding the turnout is easily found, and the whole affair can be shifted at will by any of the ordinary rules.

As an example: Say a frog, number n, is to be put in a track of radius R at a point opposite b^1 in the center line of the track. Measure a tangent length $g\,n$ back from b^1 and you have I, the common *P. I.* of main track and turnout. From this *P. I.* a deflection θ and length $g\,n$ locates the point of switch A. With back sight on A as established, deflect $\theta + F$ or $F - \theta$, according to whether the turnout is in the same direction as the main curve or not. Measure $g\,n$ and you have the point on the turnout radial to the point of frog. Exact point of frog under rail can be set by turning 90° from either subtangent and measuring $g \div 2 =$ half of the gage. The straight track work is too simple to need an example. Fig. 1 shows a turnout from straight main track. Figs. 2 and 3 show turnouts from the outside and inside of curved main track.

Respectfully,
Jos. P. White.

1601 Calvert St., Baltimore, Md., April 20, 1908.

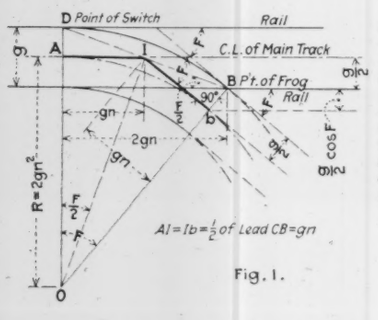

D Point of Switch
Rail
C.L. of Main Track
B P't. of Frog
Rail
A
I
gn
2gn
R=2gn²
Al=Ib=½ of Lead CB=gn
0
F=Frog Angle ∴ R=Rad.
½ cot F/2 = n = Frog Number = Length ÷ Breadth.
cot F/2 = 2n
CB=DC cot F/2 = 2gn = Lead
Al=Ib=gn = g/2 cot F/2 = ½ Lead
= subtan Arc Ab of Turnout from Pt. of Switch to Pt. of Frog.
OA=Al cot F/2 = gn x 2n = 2gn² = Radius of Turnout on Center Line.

Fig. 1.

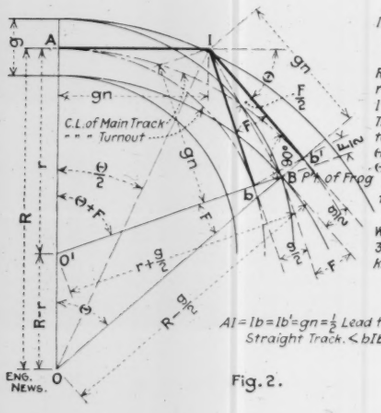

A
I
gn
C.L. of Main Track
C.L. of Turnout
B P't. of Frog
R
r
θ
θ+F
0
0'
Ib'=b'B cot BIb' = g/2 cot F/2 = g/2 x 2n = gn
Ib'÷Ob' = gn/R = tan θ/2
R=Rad. of Main Track
r = " " Turnout
I = Common Pt. of both Tracks from Switch Pt. to Pt. of Frog.
θ = Central ∠ of Main Track
(θ)+F " " " Turnout both from Pt. of Switch to Pt. of Frog.
When R and r are given 3 Sides in △ O'BO are known.
Al=Ib=Ib'=gn=½ Lead for Straight Track. ∠ bIb'=F
ENG. NEWS.

Fig. 2.

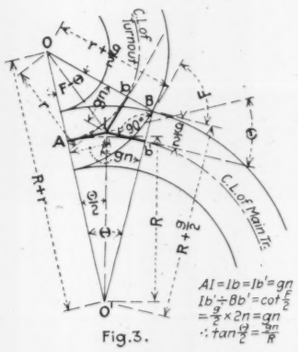


Fig.3.

Fig. 1. Turnout from Straight Main Track.

Fig. 2. Turnout from Outside of Curved Main Track.

Fig. 3. Turnout from Inside of Curved Main Track.

The Engineering Control of Federal Public Works.

Sir: Having read with much interest the excellent article by Mr. Francis C. Shenehon, in your issue of May 14 last, I feel that he has fairly stated the situation. A plan of organization which denies to certain of its members the opportunity to rise to its highest grades is for that reason alone open to serious objection.

For many years I have realized this fault with our existing system, but can this trouble be overcome without turning our public works over to political control?

A civilian organization, pure and simple, along any of the lines heretofore proposed would be deep in the mire of spoils politics after a few changes in the administration of the Government,—certainly so if those changes were changes of the political party in power.

The Reclamation Service, which seems to have been doing creditable work so far, has, since its organization, been under the administration of one party, and for nearly the whole time under the administration of our present Executive. No political attack has been made upon it. A few alternations of the political parties in control of the Government, however, will be bound to result in many changes, and they will not be changes for the better, so far as the interests of the Reclamation works are concerned.

In the very nature of our "government by parties" this is bound to occur. The civil service laws cannot stop it. These laws act fairly well to protect the public service from the spoilsmen when those in control are not amenable to political pressure. Otherwise gradual changes would be made insidiously and with certainty. And this is bound to result with any purely civilian organization. It is merely a question of time. Does the country really want spoils politics to be applied to its public works?

The excellence of the work of the Corps of Engineers of the Army has been primarily due to the freedom of that Corps from political control. It is not because the members of the Corps are graduates of West Point (excellent as is the general character of its graduates), but because these men are each protected by a commission and cannot arbitrarily be removed or overslaughed.

Wrongdoing can be detected, and, when proved to the satisfaction of a court martial composed of senior officers, who can have no personal profit from the result, can be suitably punished. But such punishment cannot be given impulsively or arbitrarily or from political motives. It must be for good and sufficient cause and after a trial by a proper and capable tribunal.

There is but one way to overcome the objection raised by Mr. Shenehon without ultimately honeycombing our public works with spoils politics. It is to have a corps of commissioned civil engineers, irremovable except for cause, and then by a tribunal formed on the same lines as a court martial. Have but a percentage of the total engineering force commissioned, but have that percentage in control, and then recruit that commissioned percentage from time to time and under suitable regulations from the assistant engineers who have shown themselves worthy.

Congress is willing to commission men as officers of the Army, as officers of the Navy, and as officers of the Revenue Cutter service: Will anyone maintain that it is yet prepared to commission men as Civil Engineers and give them a similar legal status?

Until it is, it will be best to stick to the system that has worked so well for a century, and that has upheld its record through all kinds of political changes. This system has its faults, of course, and probably its greatest fault is the one so well pointed out by Mr. Shenehon, but these faults are as nothing when compared to the real evils of a political control of our great public works.

Very respectfully,
C. S. Riché,
Major, Corps of Engineers, U. S. Army.

U. S. Engineer Office, Rock Island, Ill., May 18, 1908.

[Major Riché's suggestion appears to us an admirable one. The Corps of Civil Engineers in the Navy is recruited from civilian engineers and would form a good precedent for the admission of civilians of proved ability and experience to the Corps of Engineers of the Army.—Ed.]

Diagrams for Finding Economic Thicknesses of Reinforced-Concrete Slabs.

Sir: You reproduce in your issue of June 20, 1907, a letter of Mr. Reed, bearing on the subject of economy in the design of reinforced-concrete beams. The writer of these lines believes that the tables designed by the author are inadequate for practical use. The following scheme for the design of diagrams may be adapted to any local conditions of cost of the used materials, as well as to their assumed qualities, concerning safe stresses and moduli of elasticity.

Mr. Reed has the just idea that the maximum of economy is obtained when the stresses in the steel and in the concrete reach their safe limits together. This is true (for the usual ratios of cost, of safe stresses and of moduli of elasticity), but only in those cases where the cost of the forms of the beams is not to be considered or is constant, i. e., only for slabs. [It is also true when the cost of forms is proportional to the volume of concrete.—Ed.] But even for slabs it cannot be supposed that the theoretically most economic depth of concrete and the required percentage of steel will practically be applicable, since the depths of slabs are generally fixed as multiples of inches or half inches, and the reinforcements also are spaced in distances of whole inches.

Diagrams designed as described below will allow finding in an easy manner the practically available economic depth and spacing and will also be of use for estimating costs, the cost of floor per square foot being shown on the diagram itself.

A separate diagram is required for each set of values of (1) ratio of stresses in steel and concrete, (2) ratio of moduli of elasticity of steel and concrete, (3) cost of concrete per cubic foot, and (4) cost of steel per cubic foot. The quotient of stress-ratio divided by elastic ratio will be called r. Then to make the diagram requires the following calculations: Let r vary by tenths,

and calculate the corresponding values of per cent. steel, distance from top of beam to neutral axis, and distance from center of steel to center of pressure in the concrete. Then for each possible value of slab thickness, i. e. distance from top of slab to center of reinforcement, as 2, 2½, 3 ins., etc., calculate the moments corresponding to each r. It will be easy to calculate also the corresponding cost of slab per square foot. With moments as abscissas, make a diagram with cost per square foot as ordinate, and in the lower part draw curves of per cent. of reinforcement on the same abscissas, for the different slab thicknesses.

To use the diagram, find the moment of all loads, including the weight of the concrete below the steel. Choose any depth of slab, find its weight, and add the moment produced by it to the former one. Now, seek on that curve of cost which corresponds to the chosen depth the point given by the total moment. If this point is on the right side of the break in the curve, i. e., in that part where the stress in the concrete determines the moment capacity, try the next greater depth of slab; if it is on the left side, try a smaller depth of slab. Continue this till the points found on two neighboring curves are on different sides of the respective breaks of the curves. Then the smaller of the two values of cost will indicate the depth which is to be chosen and at the same time will give the cost of slab per square foot. On the same vertical line will be found in the lower part of the diagram the required percentage. A short practice in the use of this table will enable one to find without trying at once the most economic depth.

To allow for the fact that the reinforcement bars are also spaced in distances of whole multiples of an inch we have to draw another diagram; basing on the supposition that for all different thicknesses of slabs we use a uniform size of bars. The curves of cost will be replaced here by stepped lines showing what percentages are obtained by the different usual spacings of bars of a chosen size in slabs of varying depths, the corresponding moments being found by interpolation between the previously calculated values of percentages and moments. These moments, of course, will be the maximum moments which a slab of fixed depth and reinforcement is able to carry. The design of such a diagram will be readily understood.

Yours very truly,

R. E. Steinsberg.

1161 Amsterdam Ave., New York City, May 12, 1908.

Compensation of Grades on Curves.

Sir: May I offer as a contribution to the discussion of compensation of grades on curves appearing in your issue of April 16 some extracts from Raymond's "Elements of Railroad Engineering," which has been published recently. At p. 177, after a considerable discussion, is found the finally adopted formula for curve resistance:

$$R_c = 0.4 + (0.21 + 0.035a)\ D,$$

Here a is the length of the wheelbase, and R_c is in pounds per ton. After further discussion of obliquity of traction and variation of resistances for passenger trains and freight trains, the subject of curve compensation is taken up on p. 181 as follows:

It is customary to offset curve resistance on heavy grades, and on all grades where the combination of curve resistance and grade resistance would more than equal the grade resistance of the ruling grade of the road or division, by reducing the grade. Thus, if a curve occurs on the ruling grade, that grade would be reduced through the curve by a grade of resistance equivalent to that of the curve. If a curve occurs on a minor grade, the grade would be reduced only enough to make the resulting total resistance equal that of the ruling grade. Of course no change is possible on a level. On a crooked road of very light gradients, such as the New York Central Ry. from New York to Albany, a practically level stretch for 150 miles, curve compensation is impracticable, the curves being in effect the ruling grades. Since they are short, they could be operated as momentum grades, were it not desirable to traverse any one curve at a uniform speed. The usual allowance in compensating on ruling grades is from 0.04 to 0.05% per degree of curvature. An investigation of the proper compensation for varying rates of grade based on the previously derived expressions for curve resistance will be made.

Let three ruling grades be considered: 0.5%, 1.0% and 2.0%. Let there be a 5° curve long enough to hold an entire train, and let the train be a fully loaded, maximum train for a ten-wheel locomotive of the following dimensions:

Cylinders	19 × 26 ins.
Working pressure	190 lbs.
Heating surface	2,164.9 sq. ft.
Diameter of drivers	54 ins.
Weight on drivers	104,340 lbs.
Rigid wheelbase	12 ft.
Total weight, engine and tender	240,000 lbs.

At 10 miles an hour, on the three grades considered, if the track is straight, this locomotive can haul the following loads behind its tender:

Grade, per cent.	0.5	1.0	2.0
Load, tons	1,722	960	470
Load, cars (say)	40	22	11
Curve resistance, total	4,346.6	2,574.9	1,435.7
Per ton per degree, lbs.	0.467	0.477	0.485
Equiv. grade reduction, per cent.	0.0233	0.0238+	0.0242+

Assuming that the cars have 5-ft. trucks, the resistance in pounds per ton for cars, tender, and engine truck on the 5° curve is 2.325 lbs., and for the engine drivers 3.55 lbs. The total curve resistance on the three grades, the resistance per ton per degree, and the equivalent grade reduction, are, therefore, as shown.

Contrary to certain published observations, the compensation is greater as the ruling grade is greater, due to the greater proportion of weight on the longer wheelbase, but the difference is so slight it may be neglected. A locomotive with longer wheelbase and no greater hauling capacity would indicate a greater reduction than that given. But it is thought that on good track, curve compensation of 0.025% per degree will be found sufficient for 5° curves. The compensation, however, should vary with the degree of curve, and the following values are suggested:

Degree of curve	1	2-4	5 and over
Grade compensation, per deg.	0.04	0.03	0.025

When there is no necessity to save in gradient, full compensation even up to 0.05% per degree for all curves can do no harm.

With poor track, and badly curved rails, compensation should be high.

The final conclusion seems to agree very well with the best practice as indicated in your discussion.

Whether or not to fully compensate minor grades may be a matter of available money. Where it can be done without cost it would seem certainly to be good policy; where it involves additional expense, it may be a matter for determination. If the grades are planned as the result of careful economic study, then, unless the ruling grades are recognized as temporary, perhaps little would be gained by compensating minor grades more than indicated in the foregoing extract.

Possibly there is room for a difference of opinion as to whether curves should be compensated when they occur immediately below a summit station. Failure to compensate here is not quite the same as the introduction of the ascending grade into the station. While the failure to compensate introduces a resistance that helps to slow down the entering train, it also provides a resistance that reduces the accelerating effect of the down grade on the leaving train, and a case can readily be imagined where the entire accelerating effect would be eliminated.

It would seem, therefore, that no hard and fast rule for such situations can be made. It is difficult, in fact, to lay down hard and fast rules covering all possible cases in any line of railway practice, and perhaps in this case the general principle that should govern is this: Wherever in the judgment of the engineer failure to compensate a curve would in any way interfere with the movement of trains, the curve should be compensated.

Yours very truly,

Wm. G. Raymond.

Dean, College of Applied Science, State University of Iowa.

Iowa City, Ia., May 4, 1908.

Compensation of Grades at Stopping Points.

Sir: In the article on "Compensation of Grades on Curves" in your issue of April 16, the reduction in grade at stations is mentioned, but its proper amount is not discussed by either Prof. Webb or by Mr. Taylor.

The 0.1% reduction that several railways use in practice is less than would seem to be required, from the consideration of the starting resistances. We must assume that the engine, after a rest on the siding, has reserve steam power to start and pull through the upper turnout. An engine approaching a stopping point on a long grade is not apt to have any steam in reserve, as Mr. Taylor points out. A train must often slow down or come to a dead stop while the switch is being thrown, and not only will the compensation of the curve immediately below the siding be required, but the reduction for station should be carried below the switch to assist the train in starting and in pulling through the turnout. The curvature on a turnout from tangent is twice the frog angle, or 11° 27′ for a No. 10 frog, in a distance of about 250 ft. Hence the compensation for curvature alone in this case, on the basis of 0.035 ft. per degree, should be 0.41 ft. This would not be fully allowed for, in the turnout distance, by the reduction of 0.1% for the station.

It would seem good practice to keep the reduction for stopping places as low as starting conditions on tangent would allow, and to depend upon a reduction of grade beyond the switches in the main track to compensate for the turnout resistances. The curves in the main line then require compensation at stopping places (for the local trains) as well as elsewhere.

On roads with heavy traffic, where freight trains should be able to pull in and out of sidings with despatch, the consideration of starting and turnout resistances assumes some importance.

Yours truly,

Winfield Holbrook.

Granite, Colo., April 24, 1908.

We submitted the above letter to Prof. Webb and Mr. Taylor, and also to some other railway engineers. The following replies were received:

Sir: Apparently the points mentioned by your correspondent as to the extra resistance encountered in starting trains, are fully justified. Of course such a resistance is inevitable, and it frequently happens that it is impracticable to compensate for this extra resistance by any amount of reduction in grade. That particular spot on the road must be considered as one at which there will unavoidably be extra resistance, and the power of the engine and the loading which may be placed behind the locomotive must be planned accordingly.

It seems to be apparent in most of the discussion and comment that have been started by the rules which I published some time ago for the compensation of curvature, that the various commentators have lost sight of the underlying principles of curve resistance, and have endeavored to apply the rules with actual literalness to situations where they are not applicable. These principles may be very briefly restated as follows.

1. Curvature adds to the resistance and increases the virtual grade.

2. This virtual increase in the grade may frequently be avoided by reducing the normal grade until the virtual grade on the curve is the same as the normal grade on the tangent.

3. Such compensation is only accomplished by a sacrifice of elevation which is sometimes a serious matter, especially on a ten-mile stretch of ruling grade of the road.

4. Any combination of conditions which will permit the avoidance of this sacrifice should be used.

One of these methods is the utilization of the momentum of a train when it comes to a stop; but even this becomes dangerous provided the train is compelled to start again on the ruling grade. The case mentioned by your correspondent of a train being compelled to stop for the opening of a switch before the regular station, is a case in point. In such a case, so far as the ruling grade is concerned and its effect on the length of trains, the switch is just as much a station stop as the regular station further on.

I think it may be said in general that no one should attempt to apply the rules for compensation of curvature unless he is so thoroughly familiar with the general principles on which such rules are based that he may modify those rules in their application to any particular case which may come up.

While I still think that the rules as originally stated by me are usually applicable, it is unquestionable that there are numerous instances where a literal application of them will give absurd results which violate the principles upon which the rules are based.

Very truly yours,

Walter Loring Webb,
Consulting Engineer.

2222 Land Title Bldg., Philadelphia, Pa., May 5, 1908.

Sir: It seems to me the point made that a different rate of compensation should be used for the approach to sidetrack from the rate used for leaving the sidetrack, has considerable merit, because the condition mentioned (that an engine may be low in steam pressure after a long pull) is an ordinary one.

On the other hand, however, it will be frequently found that sidetracks are not in perfect surface, and in many cases are slightly below the grade of the main track. The resistance is thereby increased. A rule of this kind must be general and must cover a variety of conditions. It would seem to me, therefore, that the basic principle should be the rate of compensation to create a condition similar to that of starting a train on a maximum grade on straight track, with a reduction of steam pressure of, say, 25 lbs. below the popping or blow-off point. Such a rate of compensation should be applied in advance of the entering turnout, at the leaving end of the siding, and following the leaving turnout.

This principle should also be followed out on a track that is protected by automatic block signals and compensation made for stopping at every signal.

Yours truly,

H. R. Safford.

Chief Engineer Maintenance-of-Way, Illinois Central Ry.

Chicago, May 19, 1908.

Notes and Queries.

P. A. S., Nebraska City, Neb., asks if there is such a thing as a brick cleaning machine, to remove the mortar from old bricks.

TRACK AND GRADE IMPROVEMENTS on the Pennsylvania R. R., as initiated in 1902 by President Cassatt in his large scheme of reconstruction, are now announced to be partly accomplished on the line between Pittsburg and Trenton. An instance given in detail will show the thorough character of these improvements: Tunnelton to Blairsville—The distance on the old line was about 8.9 miles. The distance via the new line is 7.6 miles. The maximum curvature on the new line is 2 degrees. The total curvature on the old line was 1,112 degrees 14 minutes, the total curvature on the new line is 353 degrees 55 minutes, a saving of curvature of 748 degrees 19 minutes. The new eastbound grade on this line is .3%, the new westbound grade is .6%. These grades are compensated for curvature.

AN UNUSUAL BUILDING ACCIDENT: FOUNDATION FAILURE DURING CONSTRUCTION.

A new hospital building in Pittsburg, Pa., just approaching completion, in the early part of last week developed settlement cracks to an alarming extent, and for a time threatened collapse. This is so unusual a happening as to merit general attention. The full circumstances of the failure are not yet explored, but it seems certain at present that the walls of part of the structure must be torn down and rebuilt on new foundations. The following statement, from information obtained at our request by a Pittsburg engineer, gives the facts of the accident up to the end of last week.

VIEW ALONG FRONT OF THE EAST WING, HOMEOPATHIC HOSPITAL, PITTSBURG, PA., SHOWING SETTLEMENT.

The Homeopathic Hospital is being erected by the Homeopathic Hospital Association at Center and Liberty Avenues, Pittsburg. The long front of the building faces north, and has a length of 202 ft.; the depth is 46 ft. 6 ins., and a narrow extension at the middle projects 20 ft. farther to the rear. About 45 ft. at either end is four stories high, topped by a pent-house, while the middle part is six stories, plus a pent-house. The front and rear walls of the 4-story and 6-story parts are in line.

The hospital is built of brick, steel and terra-cotta. The external walls are brick bearing walls. There are two rows of interior columns, spaced 13 ft. 6 ins. apart from front to back and 22 ft. apart in the row. The outer ends of the floorbeams in the outer bays rest on the exterior walls. The floors are flat arches of hollow tile, while the roof is reinforced concrete. The interior columns rest on concrete piers, 8 ft. square to 9 ft. 1 in. square. The walls have rubble masonry foundations set on concrete footings 12 ins. thick. The wall footings are generally 32 ins. wide in the 4-story part and 40 ins. wide in the 6-story part. The building was put under roof several weeks ago.

On Tuesday, June 2, cracks were observed in the walls of the East wing, and on this and the following day the movement of the walls was so alarming that the John Eichleay, Jr., Company was called in, under the supervision of Mr. Herman Loeb, to jack up the portions which were settling, in order to prevent more serious movements. Blocking and jacks were placed Thursday and the front and rear walls were also braced together, and sufficient support given to them to hold them. The photograph herewith shows some of the appearances of the settlement.

From an inspection made on June 6, the foundation walls of the East wing have moved downward and inward, principally the North (front) wall, causing the cellar floor to rise about 2 ft. The inward movement of the North wall was 9 ins., and its settlement 11¾ ins.; the South wall moved inward only about 1¾ ins. and settled 2⅝ ins. Measurements of settlement made between June 2 and June 5 showed the fol'owing figures:

		North wall, ins.	South wall, ins.	
June 2.....	7 p. m.	$4\frac{1}{4}$	0	Measured opposite second pair of columns from east end.
June 3.....	9 a. m.	$8\frac{1}{16}$	$2\frac{1}{16}$	
June 3.....	5 p. m.	$9\frac{1}{4}$	....	
June 4.....	4.35 p. m.	$11\frac{1}{4}$	$2\frac{7}{16}$	
June 5.....	7.30 a. m.	$11\frac{3}{4}$	$2\frac{5}{8}$	

The interior column piers show no movement. The settlement of the walls carrying down only the outer ends of the outer bays of the floor, the walls were free to move inward correspondingly. As a result they do not show much tilt except where the East wing adjoins the six-story middle portion. Here the roof held the wall out until the settlement became large enough to separate them.

The workmanship, as judged from the condition of the structure, appears to be very good. Thus, considering the amount of movement that has taken place, surprisingly few cracks have developed in the foundation walls. The roof, where the walls settled away from it, stands clear of the cornice, cantilevering over from the middle columns.

The foundation is evidently the seat of the trouble. The soil on which the footings rest is a hard, dry clay that was difficult to pick, locally known as hardpan. Mr. William Metcalf, President of the Hospital Association, inspected the excavations, in company with the architect, Mr. C. Emil Müller, before concrete was placed, and found it satisfactory. The architect had a test pit dug near the east end, 4 ft. below the footing course, and found the same kind of clay as at the footing. Test pipes, 1½-in. diameter, were driven in the trenches, with 16-lb. mauls, but they could be driven only some 4 ft. There was some "fire-clay" in the excavation, but all of it was above the footing course. Part of the excavation in the West wing was carried below the general foundation level, for a machinery room, so that even without borings those in charge felt satisfied that the underlying soil was able to carry the loads imposed.

The building was designed for a live-load of 75 lbs. per sq. ft. on all floors, and the footings were proportioned for maximum pressures not to exceed 8 tons per sq. ft., though the average foundation pressure at present is probably not over 2 tons per sq. ft. The interior column footings are evidently intended for much lighter unit-loading than the wall footings.

It is impossible at present to say with certainty that there was no quicksand under the clay, but the fact that the column piers show no movement renders this improbable. The trouble appears to be due to the failure to prevent the surface drainage from reaching the foundations. The rainfall during May was above normal, being 3.84 ins. at Pittsburg in place of the normal 3.30 ins.; rain fell on 24 of the 31 days of May. Most of the rainfall over the area of the building reached the gutters and passed into the downspouts, which, terminating some 6 or 8 ft. above ground, dropped the water on the filling between foundation walls and the natural soil.

NOTES FROM ENGINEERING SCHOOLS.

UNIVERSITY OF NEVADA.—Mr. Clarence H. Mackay has announced that he will contribute $6,000 annually to the maintenance of the school of mines at the State University. This is in addition to large gifts previously announced.

UNIVERSITY OF IOWA.—The University of Iowa engineering building and contents were damaged June 8, by fire started by a gas jet. The chief loss was sustained by Prof. R. H. Baker, whose geometric models, invented by himself, were destroyed.

RENSSELAER POLYTECHNIC INSTITUTE.—Dr. M. A. Hunter, from the testing laboratory of the General Electric Co., at Schenectady, N. Y., has been made Assistant Professor in the Department of Electrical Engineering. He will teach electrochemistry and physics.

CASE SCHOOL OF APPLIED SCIENCE.—At the close of the recent commencement exercises of this institution, Prof. Chas. H. Benjamin, M. Am. Soc. M. E., received the honorary degree of Doctor of Engineering. Dr. Benjamin, at one time President of the Cleveland Engineering Co., Cleveland, O., was formerly Professor of Mechanical Engineering at the Case School of Applied Science. Last August he was appointed Dean of the Schools of Engineering of Purdue University.

PENNSYLVANIA STATE COLLEGE.—Prof. John Price Jackson, M. Am. I. E. E., Professor of Electrical Engineering, has been appointed Dean of the School of Engineering. Dean Jackson is an alumnus of Pennsylvania State College, and as the associate of former Dean Reber has already proved his ability as an administrator.

Prof. Walter R. Crane, M. Am. Inst. M. E., of the School of Mines, Columbia University, has

been elected Dean of the School of Mines and Metallurgy.

UNIVERSITY OF ARKANSAS.—A new course, "Cement Engineering," will be offered next fall at this university. The degree of Bachelor of Science is to be given for special work in the geology, examination and testing of cement materials and in the design and operation of cement plants, in addition to general engineering. The proximity to the school of a number of well-equipped plants, as well as of outcrops of limestone and shale suitable for the manufacture of Portland cement, will materially facilitate such studies.

COLUMBIA UNIVERSITY.—Mr. Arthur L. Walker, M. Am. Inst. M. E., has been appointed Professor of Metallurgy and administrative head of the Department of Metallurgy in the School of Mines. Prof. Walker received the degree of E. M. from Columbia with the class of 1883. He was for many years connected as chemist, superintendent, and consulting engineer with the Old Dominion Copper Co., of Globe, Arizona, and from 1893 to 1897 acted as manager for the Baltimore Electrolytic Refining Co., of Baltimore, Md. Later his services have been retained by the Guggenheim Smelting Co. and the American Smelting and Refining Co. as manager and consulting engineer.

FLOODS resulting from unusually heavy rainfalls have done great damage during the past two weeks in Oklahoma, Texas, Arkansas, Kansas, Nebraska, Montana and Minnesota. The railways have been heavy sufferers from washing out of tracks and destruction of bridges and culverts. High water in both the upper Mississippi, the Missouri and the Illinois rivers has raised the river at St. Louis above the danger line.

IN AN INTERURBAN RAILWAY COLLISION near Annapolis, Md., June 5, nine persons were killed and from 15 to 20 injured. The accident occurred on the Washington, Baltimore & Annapolis Ry., and is reported to have been caused by a mistake in orders fixing the point of passing by the two cars concerned; these were practically upon each other before they came into sight in the vicinity of Camp Parole, a station two miles out of Annapolis. The inbound car was completely telescoped and left the rails. The equipment of this electric railway was fully described in Engineering News, Feb. 20, 1908.

THE BLACKWELL'S ISLAND BRIDGE INVESTIGATION has been financed by an appropriation of $30,000 by the Board of Estimate and Apportionment. The New York "World" of June 6 says:

> Prof. W. H. Burr, who draws more salaries from the city than any other one man, and W. J. Hodge, of the engineering firm of Boller & Hodge, have been selected as the experts to make the inspection. If they disagree a third engineer is to be called in. The two engineers are to receive a fee of $10,000 each, and the remaining $10,000 appropriated yesterday is to pay the expenses of the investigation.

A HORSE CAR RAILWAY in New York City crossing the down-town business district at Fulton St. has been abandoned because it did not pay. The line was about a mile long and has been operated with a rolling stock consisting of five old cars, run at such infrequent intervals that people walked rather than use the cars. The road was bonded for $500,000 and $500,000 of stock additional was owned by the defunct Metropolitan Securities Co.

AN EXPLOSION IN A PREST-O-LITE PLANT at Indianapolis, Ind., June 6, partly wrecked the establishment, caused heavy damage to surrounding buildings, including a hospital, and injured a number of persons. This is the third serious accident which the company has suffered in this city within a year. The plant manufactures and fills gas tanks at high pressure for automobiles and localities where there are no gas or electric light works. It is thought that an employee attempted to machine burnish one of the small automobile tanks while it was charged with gas and the friction caused the gas to expand and explode; fire was communicated to several large gas drums, four loud and distinct reports following.

THE BURSTING OF A BOILER-TUBE on the armored cruiser "Tennessee," flagship of the Pacific fleet, June 5, brought death to seven of the crew and serious injury to nine others. The boiler was of the standard, tubular, Babcock & Wilcox type as used on a number of American warships. One of the 4-in. tubes in the bottom tier burst. The break is said to have been less than 6 ins. in length. The hot water and steam escaping under a boiler pressure of some 220 lbs. filled the fire-room and blew the burning coal from the grates among the stokers. There are 16 similar fire rooms on the ship, but each is separated from the other by steel doors, and the men in adjoining compartments were uninjured. The "Tennessee" was one of the U. S. cruisers named in the charges filed at Pittsburg, Nov. 9, 1906, as having defective boiler tubes.

THE INLAND WATERWAYS COMMISSION was reappointed by President Roosevelt on June 6. The members of the former Commission were reappointed with the exception of Gen. Mackenzie, who has just retired as Chief of Engineers. The President has added to the Commission Senator Allison, of Iowa; Representative Jos. E. Ransdell, of Louisiana, one of the most active workers for Waterway Improvements, and Prof. Geo. F. Swain, of the Massachusetts Institute of Technology. The members who are reappointed are: Representative Theodore Burton, Chairman; Senator William Warner, Senator Francis G. Newlands, Senator John H. Bankhead, Gifford Pinchot, Chief Forester, Department of Agriculture; F. H. Newell, Director of the Reclamation Service; Herbert Knox Smith, Chief of the Bureau of Corporations; Dr. W. J. McGee, Department of Agriculture.

A NATIONAL COMMISSION on the Conservation of Natural Resources was appointed by President Roosevelt on June 8, in accordance with the resolution adopted at the recent White House conference. The Commission is to be organized in four sections to cover the four subjects of Waters, Forests, Lands and Minerals. The Section on Waters is identical with the Inland Waterways Commission. An Executive Committee is to supervise the organization of the whole. The members of the Commission are as follows:

Waters—Theodore E. Burton, of Ohio, chairman; Senators William B. Allison, of Iowa; Francis G. Newlands, of Nevada; William Warner, of Missouri, and John H. Bankhead, of Alabama; W. J. McGee, Bureau of Soils, Secretary; F. H. Newell, Reclamation Service; Gifford Pinchot, Forest Service; Herbert Knox Smith, Bureau of Corporations; Representative Joseph E. Ransdell, of Louisiana; Prof. George F. Swain, of the Massachusetts Institute of Technology; the Chief of Engineers, United States Army.

Forests—Senators Reed Smoot, of Utah, chairman; Albert J. Beveridge, of Indiana, and Charles A. Culberson, of Texas; Representatives Charles F. Scott, of Kansas, and Champ Clark, of Missouri; J. B. White, of Missouri; Professor Henry S. Graves, of Yale Forest School, Connecticut; William Irvine, of Wisconsin; ex-Governor Newton C. Blanchard, of Louisiana; Charles L. Pack, of New Jersey; Gustav Schwab, National Council of Commerce, of New York; Overton W. Price, Forest Service, secretary.

Lands—Senators Knute Nelson, of Minnesota, chairman, and Francis E. Warren, of Wyoming; Representatives John Sharp Williams, of Mississippi; Swagar Sherley, of Kentucky, and Herbert Parsons, of New York; ex-Governor George C. Pardee, of California; ex-Governor N. B. Broward, of Florida; James J. Hill, of Minnesota; Charles McDonald, President American Society of Civil Engineers, New York; Murdo MacKenzie, of Colorado; Frank C. Goudy, of Colorado; George W. Woodruff, Interior Department, Secretary.

Minerals—Representative John Dalzell, of Pennsylvania, chairman; Senators Joseph M. Dixon, of Montana; Frank P. Flint, of California, and Lee S. Overman, of North Carolina; Representatives Philo Hall, of South Dakota, and James L. Slayden, of Texas; Andrew Carnegie, of New York; Professor Charles F. Van Hise, of Wisconsin; John Mitchell, of Illinois; John Hays Hammond, of Massachusetts; Dr. Irving Fisher, of Yale University; Joseph A. Holmes, Geological Survey, Secretary.

Executive Committee—Gifford Pinchot, chairman; Representative Theodore E. Burton, Senators Reed Smoot and Knute Nelson, John Dalzell, W. J. McGee, Overton W. Price, G. W. Woodruff and Joseph A. Holmes.

Mr. Pinchot's appointment as chairman of the executive committee carries with it the chairmanship of the commission.

THE ABUTMENT OF THE UPPER BRIDGE, on the American side of Niagara Falls will be examined June 14, to determine whether or not the water from the discharge tunnel of the Niagara Falls Power Co. is undermining or otherwise damaging this piece of masonry. It has been considered for many months that the outrush of water from the tunnel was somewhat of a menace to the safety of the great steel arch that spans the Niagara gorge for the torrent of water washes very close to the abutment as it mingles with the flood of the river below the falls. When it was found that the abutment was endangered, an effort was made to protect it with a steel sheeting, but the tremendous rush of the water from the portal caught one of the sheets intended to be lowered and swept it away. The International Railway Co. has now decided to determine the exact condition of the foundation of the abutment. This will necessitate shutting down the two large power stations of the Niagara Falls Power Co. While the water is thus shut off divers will be lowered to make a thorough investigation to ascertain what is necessary to insure the safety of the abutment.

During this shut-down, when the water is out of the tunnel, the engineers of the power company will inspect the tunnel and wheel pits to ascertain the extent of any changes since the last inspection, June 1, 1902. In order that the stations may shut down without serious inconvenience, power customers have been notified to close their works between the hours named. To maintain the electric-car service of the Buffalo-Niagara region, the plant of the Canadian Power Co., at Victoria Park will be called upon to supply current through the existing cable connections across the river at Black Rock and over the upper bridge.

THE TWO LARGEST FIREBOATS IN THE WORLD were successfully tested by the New York Fire Department on May 26. The "James Duane" and the "Thomas Willett" are the first boats of their type to use steam turbine direct driven centrifugal pumps. They have a deck length of 131 ft., beam 27 ft. and depth of 14 ft. On a high steel water tower aft, on the two deck turrets and above the pilot house, 3-in. nozzles are mounted, from which a total of 12,000 gallons of water per minute can be thrown while the boat is moving at full speed. When only one of these four nozzles is left open and the pumps are connected in series, a pressure of 315 lbs. at the pumps and of 230 lbs. at the nozzle throws a stream of water amounting to 4,550 gallons per minute to a height of 300 ft. and a distance of over 400 ft. Two Curtis turbine engines are direct connected to two 12-in. centrifugal Worthington pumps. The former are built by the General Electric Co. to operate at a boiler pressure of 200 lbs. and a vacuum of 26 ins. at a speed of 1,800 r. p. m.; they are rated at 600 HP., but their overload capacity makes a continuous delivery of 1,000 HP. possible.

AN ELECTRIC AUTOMOBILE made the trip from Washington to Baltimore on a single charge a few weeks ago, establishing a distance record for tours of electrically driven cars, at least locally. The odometer attached to the car on the first trip registered 51.1 miles and on the return 47. A somewhat roundabout way with bad roads and several hard grades was selected. The car was a "Detroit" Victoria, made by the Anderson Carriage Co., of Detroit, Mich., and weighed 1,800 lbs.

PERSONALS.

Mr. William C. Fisk, Assoc. M. Am. Soc. C. E., has been elected Vice-President of the Hudson & Manhattan Railways Co.

Mr. Frank R. Lanagan, Jun. Am. Soc. C. E., formerly Assistant City Engineer of Auburn, N. Y., has been appointed Deputy City Engineer of Albany, N. Y.

Mr. C. M. Pritchett, Assoc. M. Am. Soc. C. E., formerly of the Reclamation Service, has been appointed to the Philippine Service in the Bureau of Public Works.

Lieut. Wm. H. Rose, Corps of Engineers, is detailed as Recorder of the Army Retiring Board appointed to meet in Washington, D. C., by Special Orders of March 14, 1908.

Mr. Guy C. Emerson, M. Am. Soc. C. E., has been appointed Superintendent of Streets of Boston, Mass. He will have charge of all street work except that under the water department.

Mr. J. Walt. McMorrow, Assistant Engineer, Isthmian Canal Commission, has resigned after four years' service, to become Director and Secretary of the McMorrow Engineering & Construction Co. of New York City.

Mr. R. G. Kenley has been appointed Engineer of Maintenance-of-Way of the Lehigh Valley R. R., succeeding Mr. E. B. Ashby, whose promotion to the position of Chief Engineer was noted in a previous issue of Engineering News.

Capt. Francis A. Pope, Corps of Engineers, has been detailed as a member of the Alaskan Board of Road Commissioners, vice Capt. George B. Pillsbury, Corps of Engineers, who is relieved as member and disbursing officer of the board.

Mr. C. P. Williams, M. Am. Soc. C. E., Engineer of the Sun River Project, U. S. Reclamation Service, Fort Shaw, Mont., has been transferred to the Lower Milk River Project with the assignment of making a study and design of the Dodson diversion dam.

Mr. W. Byrd Page, Master Mechanic of the Pennsylvania R. R., at Camden, N. J., has been appointed Assistant Superintendent of Machinery on the Mexican Central Ry., assuming the former duties of Mr. C. H. Burk, who has been transferred to Orizaba, Mex., as Superintendent of Locomotives.

Mr. C. E. Caulfield, Assoc. Am. Inst. E. E., has become Chief Engineer of the Warren Electric Co., Sandusky, Ohio. He was formerly Engineer in charge of alternating current design for the Western Electric Co., Chicago, and earlier for the Stanley Electric Manufacturing Co., Pittsfield, Mass.

Col. Clinton B. Sears, Corps of Engineers, who has been on leave of absence in St. Louis, was placed on the retired list on June 2, having reached the age limit. He received the rank of brigadier-general for Civil War service. He has acted as Professor of Engineering at West Point, and is the author of "Principles of Tidal Harbor Improvements."

Lieut.-Col. Harry F. Hodges, Engineer Corps, U. S. A., General Purchasing Agent of the Isthmian Canal Commission, has been appointed Member of the Commission, vice Mr. Jackson Smith, resigned. Col. Hodges will be general assistant to Lieut.-Col. Goethals, Chairman and Chief Engineer.

Capt. John Kennedy Barton, Engineer Officer of the League Island Navy Yard, at Philadelphia, has been appointed Engineer-in-Chief of the United States Navy, succeeding Rear-Admiral Charles W. Rae, who died May 12. Capt. Barton was born in Pennsylvania in 1853, and received his appointment as cadet engineer in the navy in 1871. From 1901 to 1902 he served as fleet engineer of the Asiatic squadron.

Dr. Robert Bell, M. Am. Soc. M. E., Director of the Geological Survey of Canada, retired from the service June 1. His activity has extended through every part of the Dominion; the primary geological investigations of British Columbia, the Hudson Bay region and the Yukon district were made under his direction. His work on the International Committee of the Canadian and the United States Surveys was effective in combining the results achieved by both departments.

Mr. Jackson Smith, Member Isthmian Canal Commission, and manager of the Department of Labor, Quarters and Subsistence, with headquarters at Culebra, Canal Zone, has resigned, after a service of three years. In accepting the resignation President Roosevelt says:

I cannot permit this occasion to pass without expressing formally to you my appreciation of the earnest, thorough, and effective service which you have rendered in organizing the Department of Labor, Quarters, and Subsistence, and in developing it to such a state of efficiency that the task of your successor will be comparatively an easy one.

Wm. Kent, M. Am. Soc. M. E., who has been for the past five years Dean of the L. C. Smith College of Applied Science of Syracuse University, has been dismissed from the position as the result of personal differences between himself and Chancellor Day, the official head of the University, who has become widely known through his virulent attacks on the President of the United States and his published utterances in defense of the Standard Oil Co. In the issue of "Science" for May 29, Dean Kent publishes a full statement of the situation at Syracuse University, which has finally culminated in severing his connection with the institution.

Prof. Forrest E. Cardullo, the well-known authority on machine design, has also left Syracuse University, it is understood from causes similar to those which have compelled Dean Kent to leave.

Obituary.

Charles T. Davis, foreman of the standard-gage department of the Browne & Sharpe Mfg. Co., died at his home in Lakewood, R. I., May 27. He was a man of wide experience in the highest class of gage work. Mr. Davis was 46 years old.

Sir Robert Gillespie Reid, one of the most prominent engineering contractors of Canada, died at his home in Montreal, June 4, of pneumonia. He was born in Scotland in 1842 and came to America in 1871. Among his constructions are the Lachine Bridge over the St. Lawrence, bridges over the Niagara and Rio Grande Rivers, and a number of the railways of Newfoundland. He was a director of the Canadian Pacific Ry.

ENGINEERING SOCIETIES.

COMING MEETINGS.

MASTER CAR BUILDERS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 22-24. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 23-26. Annual convention at Denver, Colo. Secy., C. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 23-26. Annual convention at Detroit, Mich. Secy., C. W. Rice, 29 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-26. Annual meeting at Detroit, Mich. (In connection with convention of American Society of Mechanical Engineers.) Secy., A. L. Williston, Pratt Institute, Brooklyn, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 23-27. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 29-July 2. Annual convention at Atlantic City, N. J. Secy., Ralph W. Pope, 33 West 39th St., N. Y.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 24-25. Summer meeting at Niagara Falls, N. Y. Secy., W. M. Mackay, P. O. Box 1818, New York City.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.—The annual meeting will be held at Washington, D. C., Oct. 20-22.

WESTERN RAILWAY CLUB.—At the annual meeting the following officers were elected: President, M. K. Barnum (C., B. & Q. Ry.); Vice-Presidents, W. E. Sharp and J. F. Devoy; Secretary and Treasurer, Jos. F. Taylor, Old Colony Building, Chicago. The club has now 1,503 members, and a bank balance of over $1,900.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.—It is definitely announced that the organization meeting of this new association will be held June 22, at the Engineers' Club, 1317 Spruce St., Philadelphia, Pa. It is expected that admission to membership will be on the basis of extent of practice in chemical works or in technological applications of chemical principles on a large scale.

AMERICAN STATE GEOLOGISTS.—This new society was organized at a meeting of representatives of 20 of the state geological surveys, in Washington, D. C., May 13. Officers were elected as follows: President, H. B. Kümmel, of New Jersey; Secretary, H. F. Bain, of Illinois. A resolution was passed asking the support of state and federal authorities for an increased appropriation for topographic surveys, it being the sense of the meeting that a complete topographic map would greatly aid the administration of national forest, mineral and soil resources.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The following program has been arranged for the twenty-fifth annual convention at Atlantic City, June 29 to July 3:

Monday, June 29. Morning and Afternoon Sessions.

"Electricity as Viewed by the Insurance Engineer. Should the A. I. E. E. Interest Itself in Fire Protection?" C. M. Goddard; "Water Power Development in the National Forests. A Suggested Government Policy," F. G. Baum; "A Study of Multioffice Automatic Switchboard Telephone Systems," W. Lee Campbell; "Wireless Telephony," R. A. Fessenden; "The Measurement of Rotary Speeds of Dynamo Machines by the Stroboscopic Fork," A. E. Kennelly and S. E. Whiting; "Notes on the Electric Heating Plant of the Biltmore Estate," Chas. E. Waddell.

Tuesday, June 30. Morning and Evening Sessions.

"Measurements of Lightning, Aluminum Lighting-Arresters, Earth Resistances, Cement Resistances, and Kindred Tests," E. E. F. Creighton; "Tests with Arcing Grounds and Connections," Ernst J. Berg; "Three-Phase Power-Factor," Austin Burt; "Critical Study of the Taylor's Falls Lightning Records," Percy H. Thomas; "Engineering Features of the Southern Power Company's System," J. W. Fraser; "High-Voltage Experiments at Niagara," Ralph D. Mershon; "Fundamental Considerations Governing the Design of Transmission-Line Structures," D. R. Scholes; "The Testing of High-Voltage Line Insulators," C. E. Skinner.

Wednesday, July 1. Morning and Afternoon Sessions.

"Voltage Ratio in Synchronous Converters, with Special Reference to the Split-Pole Converter," Comfort A. Adams; "Application of Storage-Batteries to Regulation of Alternating-Current Systems," J. Lester Woodbridge; "A New Large Generator for Niagara Falls," B. A. Behrend; "Modern Developments in Single-Phase Generators," W. L. Waters; "Application of Fractional-Pitch Windings to Alternating-Current Generators," Jens Bache-Wiig; "Steam Turbine Plant; Some Possibilities Resulting from Recent Engineering Developments," J. R. Bibbins; "Thirty-Day Test on Producer-Gas Power Plant; Discussion of Results in Relation to Cost of Power," J. R. Bibbins; "From Steam to Electricity on a Single-Track Road," J. B. Whitehead; "Induction Motors for Multispeed Service with Particular Reference to Cascade Operation," H. C. Specht; "The Determination of the Economic Location of Substations in Electric Railways," Gerard B. Werner; "Conductor Rail Measurements," S. B. Fortenbaugh.

Thursday, July 2. Morning and Afternoon Sessions.

"The General Equations of the Electric Circuit," C. P. Steinmetz; "Primary Standard of Light," C. P. Steinmetz; "An Imperfection in the Usual Statement of the Fundamental Law of Electromagnetic Induction," Carl Hering; "Graphical Treatment of the Rotating Field," R. E. Hellmund; "A Minimum-Work Method for the Solution of Alternating-Current Problems," Harold Pender; "The Relative Proportions of Copper and Iron in Alternators," Carl J. Fechheimer; "A New Method of Training Engineers," M. W. Alexander; "The Relation of the Manufacturing Company to the Technical Graduate," D. B. Rushmore; "The Relation of the Manufacturing Company to the Technical Graduate," B A. Behrend

Friday, July 3. A morning session will be held if necessary to complete the program or to attend to unfinished business.

A reception and dance will be given at the Hotel Traymore, the convention headquarters, on Monday evening. The attractions of Atlantic City are so extensive that the program of entertainments has been made very light.

WESTERN SOCIETY OF ENGINEERS.—At a recent meeting the society adopted resolutions endorsing the stream-flow investigation work of the U. S. Geological Survey and recommending the passage of legislation to provide for carrying on this work. The streams are of growing importance in relation to navigation, irrigation, water supply and water power. The engineering, financial and economic measures which must be undertaken in order to derive the full benefit of the streams can be based properly only upon such information as is given by the investigations in question. The society adopted also a resolution approving the conference on Natural Resources recently called by President Roosevelt. It urged that steps should be taken for the better conservation of these resources and for the reduction of the great waste which has been incident to their exploitation.

A regular meeting was held at the society's rooms in Chicago on June 3, with the President, Mr. C. F. Loweth (C., M. & St. P. Ry.), in the chair. A paper on "The Conservation of the Forests and Water Powers of Wisconsin" was read by Mr. E. M. Griffith, State Forester of Wisconsin. He first outlined the importance of forestry as a means of securing not only a permanent supply of timber but for securing a permanent supply and equable distribution of water for purposes of navigation, irrigation, power, etc. When the forest reserve policy was first adopted in this country it encountered strong opposition owing to the public impression that it meant the elimination of forests as a source of timber supply. Since the education of the public to an understanding that the effect of the policy will be to perpetuate the supply and also to conserve other natural resources, this opposition has practically ceased. There is still opposition from the private interests, which exploit public timber lands as their own property. It is estimated that within 25 or 30 years this country will have a timber famine, and that this will continue for an equal period before the new and protected forests are able to meet the demand for timber.

In the recent conference held at Washington it was shown that measures for the conservation of water supply for purposes of water power, irrigation, navigation, etc., all lead back to the preservation of forests as the fundamental necessity. Some of the eastern states, notably New York and Pennsylvania, have undertaken their own forestry work, and it was shown that one great flood such as recently occurred at Pittsburg might cost more than the establishment of forest reserves and flood prevention measures.

In Wisconsin, the state has turned over to its Forestry Department all the state lands in the northern section. This will be increased by the purchase of lands forfeited for non-payment of taxes. These were formerly sold by the counties and purchased largely by speculators who re-sold them in small lots. Under the new law, the counties cannot sell the lands until the Forestry Department has been given an opportunity to purchase them. The Department sells the agricultural lands, and also the crop of available timber, the proceeds being used to purchase more lands. The Department has now 300,000 acres, covering the headwaters of three of the most important rivers of the state. One of the first steps taken was to establish an efficient fire-warden system. The region is a great tourist resort, and its preservation is of no small importance in this respect. It includes 20,000 acres of public lands given by the Federal Government on account of the state undertaking to protect the headwaters of the Mississippi River. The department is composed of five members, three of whom are connected with the University of Wisconsin, and none of whom are politicians.

An important feature is the cooperation with private interests. The Wisconsin Valley Improvement Co. applied for a charter to establish dams and to lease water power. This was granted last year, but puts the control of the work in the hands of the Forestry Department, besides giving the state power to control the rates charged. The location and construction of the dams is subject to the approval of the Department, which will establish the water level for each reservoir, and issue regulations as to the drawing off of the water. As far as water power is concerned, Mr. Griffith showed that some plants have had to supply their customers with auxiliary steam power owing to the fact that sufficient capacity of water power cannot be relied upon. This is due in part to lack of facilities for storing the flood waters.

Three important points are aimed at by the Forestry Department: (1) To protect the water supply; (2) To grow a supply of timber; (3) To protect the natural beauties of the country.

This meeting was the last to be held in the present quarters in the Monadnock Block. During the summer new quarters will be arranged (in the same building) in order to provide sufficient accommodation for the meetings and the library. This change is made necessary by the growth of the society. The new rooms will have an area of nearly 4,000 sq. ft. (about twice that of the present rooms). The cost of the work will be about $5,000. The architects are Holabird & Roche, of Chicago. The new quarters will be ready for occupancy for the first fall meeting in September.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. 220 Broadway, New York, June 11, 1908.

CONTENTS.

CORRESPONDENCE:

Godfrey's "Concrete": The Review Explained. Edward Godfrey 645

REVIEWS:

Steam-Turbines. Reviewed by Charles Edward Lucke 645

Secondary Stresses in Bridge Trusses. Reviewed by Henry S. Jacoby 646

Power Gas Producers. Reviewed by Alfred E. Forstall 647

Typhoid Fever 648

Corporate Finance and Accounting.—Simple Mine Accounting. Reviewed by Frederick A. Cleveland 648

Autogenous Welding of Metals 648

Bau Rationeller Francisturbinen-Laufräder. Reviewed by S. J. Zowski 649

Thermodynamics of Technical Gas-Reactions. Reviewed by Lionel S. Marks 650

Engineering Index Annual for 1907 650

Washing and Coking Tests of Coal and Cupola Tests of Coke 650

Treatise on the Principles and Practice of Harbor Engineering 650

Report on the New Croton Aqueduct, Reservoirs and Dams, 1895 to 1907 651

Grundzüge der Mechanischen Abwässerklärung. Reviewed by George W. Fuller 651

The Electric Furnace. Reviewed by Francis A. J. FitzGerald 652

Concrete Construction 653

Machine Design, Construction and Drawing. Reviewed by Amasa Trowbridge 653

PUBLICATIONS RECEIVED 654

CORRESPONDENCE.

Godfrey's "Concrete:" The Review Explained.

Sir: Kindly permit me space to say something regarding your review of my book, "Concrete," (Eng. News, May 14, 1908, p. 543). I ask this favor because I think that when an author is slapped, not to say knocked, in public he ought in justice to be permitted to make a public defence, and I believe you are just enough to give room for such defence.

Your review is just in a negative sense. You emphasize so strongly the fact that you object to the manner in which the book is made that it is difficult for the reader to perceive that you do not utter a word in condemnation of what the book says, unless it be that you say my cost figures have no exact value. Well, the text makes that clear. If exact cost data were a possibility, two neighboring contractors, bidding on a job in their neighborhood, would occasionally come near agreement in price. This they rarely do. The cost data given by me is to guide in making an approximate estimate of cost. "Exact" estimates of the cost of a structure are sometimes as far from the actual cost as an approximate estimate dare be.

A casual reading of your review would give the reader the impression that you condemn the book. It takes reading between the lines to see the vague hints that the same matter in a different shape would have filled an ambitious plan and produced a useful handbook.

To analyze the "manner" of the book and your objection. First, there are, besides about 160 pages of new matter on cement, concrete, steel, etc., and their properties and uses, two series of articles. These articles are on definite subjects and are therefore not separable; they are scarcely in need of rearrangement. Any subject treated can be found in the index. One has seldom any need of a table of contents, unless he is reviewing a book and wants to make short work of it. Following these articles are letters commenting on and criticizing them. The presence of these letters appears to be your chief objection to the book. It would not be fair to the writers of these letters for me to summarize and condense what they say. Such condensation would no doubt diminish, and might destroy, the force of their assertions. These letters add to the original articles a view that could not be introduced by revising the articles, as they present views not held by the author.

One of the dangers of permanent literature on technical subjects is its dogmatic finality. The student and the inexperienced engineer is given the impression in reading engineering books that there "are no two ways about it," and that dissent from the statements of the author is out of the question. It is not difficult to find, in the works of the highest authorities in their special line, gross errors, and to show that following these authors to the letter can lead to a structure that is not only poor design but positively dangerous. Some of these errors in the works and utterances of eminent authorities are pointed out in my book, hence the didacticism to which you object.

The book is not intended to be used for the purpose of putting in the data and grinding out the structure. It is not an automatic designer, but its aim is "to point the way to sound engineering in concrete by enunciating the principles thereof, and by laying bare the falsity of much that passes for good engineering in this comparatively new branch of construction."

Yours very truly,

Edward Godfrey.

Pittsburg, Pa., May 15, 1908.

[The text-book is an expression of knowledge, gained from reading or personal investigation of the author and has a value largely dependent upon the expert standing, more or less difficult of definition, of the man responsible for the preparation of the book. In many ways it is a mere presentation of opinions, and such opinions are accepted as truth in just the degree that the man delivering them has authority. Any one can refuse to agree with them, any one can decline to accept them, for there is no virtue in printer's ink that confers infallibility. If through some unfortunate style of writing the casual and unthinking reader assumes a "dogmatic finality" in printed statements, it is the fault of that reader in not understanding the function of a book.

Furthermore, we do not see that this impression in a reader's mind can be removed by a slipshod method of arrangement or lack of care in the principles of selection and unity. Rather will such procedure indicate, on the part of the author, a lack of confidence in his own work which, naturally, is conveyed to the reader. Therefore, equally important as the *matter*, in judging the value of a book intended to instruct and not to amuse, must be rated the *manner*. The two are interdependent and the lack of either one destroys the perfect whole. With this idea in view we purposely refrained in our review of Mr. Godfrey's "Concrete" from any extended comment on "what the book says" on account of the careless manner in which it was said.—Ed.]

REVIEWS.

Thomas's Steam Turbines Revised.

Reviewed by CHARLES EDWARD LUCKE,* M. Am. Soc. M. E.

STEAM-TURBINES.—By Carl C. Thomas, Professor of Marine Engineering, Sibley College, Cornell University. Third Edition, revised and enlarged. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¾ x 9¼ ins.; pp. 334; folding diagrams and numerous text illustrations. $4.

In preparing this new edition of his book, originally reviewed by the late Storm Bull in Engineering News of April 12, 1906, the author has in some cases heeded and in other cases ignored the pertinent suggestions of that reviewer. It was Professor Bull's opinion that the book, designed as a college text, was good, but not broad enough, that the space allotted to the different topics was not well proportioned; that 150 pages of introduction was too much and that the last four chapters on turbines proper would be improved by expansion. In this new edition the same apparent over-treatment of introductory matter is retained, which seems unjustifiable if students undertaking the subjects are well grounded in basic thermodynamics and its application to free expansion in general. If, however, the students for whom the text was intended were not well grounded, the author's retention of this material is justified.

That student difficulties have been encountered is indicated by various corrections introduced in the earlier pages. For example, on page 3, where the old edition reads:

The equation expressing the relation between force and motion is, then,

$$F = MV = \frac{W}{g} V,$$ where F is the force which,

acting for unit time, produces in the mass $\frac{W}{g}$ the velocity V.

*Professor of Mechanical Engineering, Columbia University, New York City.

The new edition has been corrected to read

The equation expressing the relation between force, mass, and acceleration is, then,

$$F = Mf = \frac{W}{g} f,$$ where F is the force which produces

in the mass $\frac{W}{g}$ the acceleration f.

At the end of Chapter I., on page 26, there is added a paragraph of definitions of impulse and reaction, which, to a well prepared reader, would seem to be unnecessary, as the meaning of the words are dependent on and explained by the formulas used. Again, on page 33 in the old edition

Let the external work accompanying the change of the volume of the gas be p_1v_1 for the gas in the vessel and p_2v_2 in the nozzle,

has been in the new edition changed to

External work p_1v_1 is done upon each pound of gas leaving the vessel, and each pound does external work p_2v_2 as it expands in the nozzle.

Chapter III., on Work Done in Heat Transformations, is an extremely elementary treatment of the work done by the difference between total heats before and after expansion. The discussion involves the temperature-entropy analysis and follows an equivalent treatment, in the preceding chapter, of the work done by the integration of PV changes. With the exception of the minor changes, noted above, these two chapters are unchanged.

In Chapter IV., on the Calculation of Velocity and Weight of Flow, the results are made to depend on the temperature-entropy analysis, and the velocity is given as the result of a fraction of difference between total heats before and after adiabatic expansion, from which the weight of flow is determined. This is followed by a treatment of reaction on the nozzle, based on the velocity and weight of flow, with some experimental tables showing the consistency between the experimental and computed values. The treatment in the new edition is precisely the same as in the old and is very clearly written.

Chapter V. is concerned with velocity, as affected by frictional resistances, and there is set down the expression for velocity in terms of difference between total heats before and after adiabatic expansion. Failure to realize complete velocities, due to adiabatic expansion, is treated as entirely due to friction and a factor is introduced as a multiplier of total heats to give the effective heat transformed as observed. While there is a diagram presented, indicating that this result is equivalent to some other law of expansion than adiabatic, no attempt is made to determine that law from experimental velocities or weights of flow, which would seem to be a good and scientific thing to do. In this connection an unfortunate and double use of the same symbol is presented, inasmuch as on page 2, f is defined as steam acceleration, whereas on page 154, f is defined as the square root of the per cent. of adiabatically available total heat difference which is realized in producing velocity. Following the expression for velocity, corrected for less total heat difference available than there would be by adiabatic expansion, the resultant quality of the steam and specific volume is computed and used in the steady flow relation to determine the cross section of nozzles, with good illustrative examples. The inverse example is also considered from the pressure and quality before and after expansion to find this corresponding available total heat difference or the per cent. of adiabatically available total heat difference suppressed or lost. This is followed by some results of experiments on this percentage of heat suppression, which, by the way, is not so named by the author.

In Experimental Work on the Flow of Steam through Orifices, Nozzles, and Turbine Buckets, there is given in detail considerable experimental data on the weight of flow through different orifices, together with the reaction at the jet, all of which serves merely the purpose of fixing certain heat-transformation coefficients for different

shapes of nozzles. This is followed by some measurements on turbine buckets for various curvatures, clearance, spacing, pressures and nozzle forms and checked by air flow in addition to steam flow, permitting, as a result, the determination of a series of coefficients called by the author "efficiency of the buckets."

The chapter is precisely the same as in the first edition. While the reviewer of the former edition considered this treatment too much expanded, it appears to the present reviewer that this is the case only relatively. While many of the details of the experiments might be omitted and the conclusions only retained and apportioned to the four succeeding chapters, this would not be justifiable, especially with young students, because the value of the coefficients depends largely on a knowledge of how they were obtained, thus giving some idea of their reliability and serving as a guide for further experimental work. If the following four chapters on the turbine proper were enlarged, as they might well be, this material on experimental steam flow would not seem too much. Some of the earlier chapters, I., II., III., constituting about 60 pages, could be easily condensed to advantage.

The chapter on the impulse turbine has been increased by about 18 pages, from the original 20 pages, by the additions at the end, including a useful diagram on the specific volume of superheated steam, computed from the Tumlirz equation,

$$V = \frac{.059637}{p} - 0.256,$$

Chapter VIII., on impulse and reaction turbines, has been enlarged by about 25 pages at various points and somewhat rearranged, part of the addition being concerned with the new calorimeter and specific-heat work of Professor Thomas, presented to the American Society of Mechanical Engineers in December, 1907.

Chapter IX. is not enlarged at all, but is slightly rearranged and the nine pages of Westinghouse Machine Co. tests, to which Professor Bull objected, are omitted. Chapter X., on marine steam turbines, is enlarged by about 15 pages, chiefly cuts and diagrams.

Reverting to Chapter VII., on Impulse Turbines, in which the theory of nozzle and bucket flow is applied to rotating wheels: The work per second for such a wheel is based on the mass of steam and the square of the steam-velocity difference through the wheel, the relation of the velocities of steam and wheel and their dependence on bucket angles being shown graphically, both for the adiabatic velocity and its fractional part due to loss deductions. This nozzle loss is treated, as pointed out above, by assuming that a fraction of the available adiabatic work is developed, which is only one of two possible methods of procedure. Such a loss may be considered due to radiation and friction or due to the operation of a law of expansion other than the adiabatic. The former method, used by the author, is the usual method of treatment for turbine work, while the latter is the more common one for reciprocating engines, leading in this case to the so-called hypothetic expansion law. A steam-loss factor is introduced and used for the vane action, which, with a windage, and mechanical-friction factor, provide means for computing what the author calls "efficiency of the wheel and turbine." This efficiency, which might easily be confused with thermal efficiency, treated later on, but without a desirable distinction, is here used as the ratio of the work obtained at the shaft to the kinetic energy of the jet. The computation, therefore, of the possible work available at the shaft, as presented by the author, involves the use of three factors, one for the nozzle-velocity loss, one for the vane loss and one for mechanical and windage-friction loss, none of which are definitely fixed for definite conditions. The same method of treatment is then extended in this chapter to the two-stage impulse turbine at which point the old edition stops. In the new edition, however, this is followed by the determination of the dimensions and spacing of rectangular Curtis nozzles and buckets. After establishing the relations between thermal efficiency and water rate, the author adds further new matter, involving assumed losses in the various parts for the design of those parts, together with a predicted thermal efficiency and water rate for the given steam and vacuum conditions. This concludes the new work of this chapter.

In Chapter VIII., already mentioned, on the impulse and reaction turbines, similar new matter has been added. Preceding the velocity diagrams a simple example is presented for assumed adiabatic expansion on the design of a 1,000 HP. three-stage machine, in which the energy losses are traced through the system, after which the various velocity diagrams, involving bucket and nozzle actions, are analyzed in detail, as in the first edition, with a small amount of valuable new matter of an explanatory sort. To the end of the chapter there is added a thermal analysis of turbines, based on variations of quality of steam through the machine. This is an excellent mode of treatment and an extremely valuable one, comparable in nature to the Pitot-tube analysis of the action of water wheels, but depending in this case for its value on the accuracy of a steam calorimeter. This steam calorimeter has been developed by Professor Thomas and it is at this point introduced into the text.

Chapter IX., on types of turbines and their operation, could be much expanded and made more valuable by dimensioned drawings in place of photographic reproductions, and by analyses of test results in the light of the previous theoretical foundations so carefully built up. In fact, by this lack of coordination between test results on complete turbines and the various theories involved, there is ignored by the author an excellent opportunity for scientific treatment of what is essentially a scientific subject. It is hoped that the author will add this in some later edition, as all the elements necessary for the treatment are included in the earlier parts of the book.

Secondary Stresses in Bridge Trusses.

Reviewed by HENRY S. JACOBY.*

SECONDARY STRESSES IN BRIDGE TRUSSES.—By C. R. Grimm, M. Am. Soc. C. E. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 9¼ ins.; pp. 140; 60 illustrations in the text and 15 tables. $2.50; English price, 10s. 6d., net.

This book is a distinct addition to American bridge literature in a field which hitherto has been practically unoccupied. Apart from a few brief articles in engineering periodicals published a score or more years ago, and some incidental references in text-books, the last chapter in Hiroi's "Statically Indeterminate Stresses" (reviewed in Engineering News, Vol. 54, page 530, Nov 16, 1905), contains the only treatment of secondary stresses heretofore available in English. That chapter, covering 21 pages, included the solution of an elementary example giving the stresses due to the rigidity of joints in a Warren truss of two panels, while the larger part of it contained the deduction of formulas and numerical examples for secondary stresses in the posts, due to rigid floor-beam and lateral connections, for both live and wind loads. Attention is called to the fact that this part of the subject is not discussed mathematically in the book under review.

The subject of secondary stresses has been investigated and the theory developed by German engineers, and with but few exceptions all the literature relating to it is published in German. The stresses in a bridge truss are broadly divided into two classes: primary and secondary stresses. Primary stresses in a truss are either tension or compression and may be caused by dead or live loads, wind pressure, centrifugal force, traction, etc. The resultant of the primary stresses acts along the axis of the member which passes through the centers of gravity of the member's cross sections, and produces simply an elongation or shortening of the member. Other stresses of flexure, torsion or shear are called secondary stresses and may be due to various causes, but chiefly to riveted joints which prevent the angles of the truss from changing when the truss is deformed under loading, and therefore necessitate bending in the members.

The author limits his treatment mainly to secondary stresses due to riveted joints in trusses. After some introductory historical notes, a consideration of the nature of the problem and some means for its solution, he presents five methods for the calculation of secondary stresses, devoting a chapter to each one. The four principal methods were developed by Manderla, Müller-Breslau, Ritter and Mohr, respectively, while the fifth one is designated as the method of least work. Mohr's method makes use of the principle of virtual work or virtual moments, while those of Manderla and Müller-Breslau attack the problem directly by means of the elastic curve. Ritter's method is a modification in which a graphical scheme is substituted for the laborious algebraic solution of the sets of equations. In all cases the solution of the problem requires the determination of the bending moments at the ends of each truss member from which the secondary stress is obtained by the ordinary formula for flexure.

In presenting one of the methods, the author indicates the assumptions and principles employed and attempts to show the principal steps in deducing the working formulas required. The result can hardly be called entirely successful. The problem of secondary stresses is acknowledged to be difficult and the reader is assumed to be familiar with the principles of least work and of virtual work, with differential equations and hyperbolic functions as well as engineering mechanics. Even one who is familiar with these subjects finds it difficult to follow or check the deductions as outlined. Since the complete mathematical development was impracticable under the limits set to the book, it would have probably served its purpose better as an introduction to the subject, to give more verbal explanation of the steps involved, and to omit some of the intermediate equations, adding definite references to the original works, where the deduction is given in full. The last three pages of the book contain the titles and authors of 55 articles and books constituting the literature of secondary stresses, but no detailed references are given in the chapters dealing with the methods of computation named above. Conciseness is commendable but may easily be carried too far. An extra sentence here or an additional paragraph there may make the text much clearer and save valuable time for the many readers who are expected to study the text and refer to it afterwards. The same criticism may fairly be made regarding some other technical books.

In presenting the four principal methods references are sometimes made to equations previously given. On account of changing a part of the notation in different chapters without explanation, additional difficulties are introduced that might have been avoided by using a uniform notation throughout. A number of typographical errors occur in which negative signs should be substituted for positive ones. On pages 27 and 29 the words subtraction should read addition.

It is to be regretted that the author did not insert at least the partial details of one numerical example worked out by what he regards as the best method, so as to show clearly the order of procedure and the correct application of the formulas, some features of which may be easily misinterpreted. Such details accompanied by hints or cautions based on the author's experience in such computations would certainly be of great service to others. An example of the simplest possible triangular truss is solved by the "method of least work" which is, however, said to be "far removed from shortening the labor."

The longest chapter, covering 46 pages, is devoted to the final results of the computation of secondary stresses for 12 simple trusses and one truss of a center-bearing swing bridge. Two of the simple trusses and the swing bridge truss were computed by the author while the rest were computed by Manderla, Müller-Breslau, Ritter, Mohr, Winkler and Patten. The types of trusses include the plain Warren, the Warren with sub-

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verticals, the double-intersection Warren, the double-intersection Warren with additional long verticals and the Pratt truss. The number of panels range from 3 to 12, the trusses being all of short spans. The American simple trusses have spans of 140 and 162 ft., while the swing span is 202 ft. long. As stated in the text, "a study of secondary stresses proves to be instructive, for it discloses the weakness in our designs, but at the same time we are also taught how to minimize defects resulting in stronger and therefore safer bridges."

It would extend this review beyond reasonable limits to indicate in detail even a small part of the interesting and valuable information given in this chapter. It is seen that the type of truss has an important influence upon the secondary stresses. The influence of verticals in the Warren truss, of riveting the diagonals together in the double-intersection Warren, of adding long verticals to the latter type, of collision struts, etc., are plainly shown by the tables. The secondary stresses are expressed as percentages of the primary stresses. Since engineers are deeply interested at present in studying compression members it will be well to give special consideration to the comparative secondary stresses in compression and tension members and to the effect of the ratio of the length to the width of a member.

A considerable number of useful suggestions are given to guide the designer in minimizing secondary stresses due to static loads, and attention is called to the importance of good detailing of the panel points. Reference is also made to the fact that "old trusses designed for loads which are much lighter than those they actually carry are very good subjects for examination, because it is here in particular within the range of possibilities that the stresses are raised to a dangerous point," especially when peculiarities of construction lead one to expect high secondary stresses.

Another chapter is devoted to other causes of secondary stresses than riveted joints in main trusses. These include eccentricities; loads between panel points in the plane of the truss; loads between and at panel points of a member supposed to turn freely around a pin; changes in temperature; misfits; brackets on posts; unsymmetrical connections; curved members; pin joints; friction at supports; cross frames; yielding of foundations and settlements of masonry. Most of these topics are very briefly discussed in a general way, while formulas are derived for the rest.

In a chapter of seven pages the problem of impact is considered, the results of Zimmerman's theoretical solution being given for the simplest case of a single constant load moving over a weightless beam of uniform sectional area, and resting on two rigid supports.

The author has rendered a valuable service to the engineering profession in this country by writing this book which gives the results of previous investigations and directs attention in an effective manner to the importance of the subject. The concluding remarks in the chapter on examples gives a hint of the great amount of time and labor involved in the computations for the three American bridge trusses made especially for this volume. The book deserves careful study by every engineer who is responsible for the design and maintenance of bridges. The publisher's work is well done, the paper being of good quality, and the typography and presswork satisfactory. It is hoped that an index will be added when another edition is issued.

Producer-Gas Plants.

Reviewed by ALFRED E. FORSTALL.*

POWER GAS PRODUCERS.—Their Design and Application. By Philip W. Robson, of the National Gas Engine Co., Ltd. London, England: Edward Arnold. Cloth; 5½ × 8¾ ins.; pp. 247; 105 illustrations, mostly in the text, and 31 tables. $3, net.

In the review of one of the first books published on the subject of producer-gas, attention was called to the need for a treatment of the subject from the standpoint of the man who was concerned with the actual working of producer-gas plants, and wished to know how to handle them so as to obtain the best possible results. Although several works on the subject have been published since that time none of them meet this need as fully as does the one now under consideration, which is devoted almost entirely to the design, construction, and operation of producers.

It is divided into three sections, the first, which takes up very nearly two-thirds of the whole volume, treating of suction gas producers; the second, which is short, dealing with pressure plants for non-bituminous fuel, and the third, occupying about one-quarter of the volume, covering pressure producers for bituminous coal.

The first section begins with the general principles covering, and the reactions taking place during, the operation of producers, which are the same whether the producer is operated by suction or by pressure, and then deals with the design, construction and operation, first of suction producers for non-bituminous fuel and second of those for bituminous coal. The treatment of the latter is rather brief, since it is the opinion of the author that the larger labor cost connected with their operation and the fixed charges on the extra first cost of the elaborate cleaning apparatus required to prepare for use in gas engines the gas produced from bituminous coal, by removing from it the tar which it contains, more than counterbalances the saving derived from the lower cost of bituminous, as compared with anthracite, coal under the conditions which obtain in Great Britain.

In chapters treating of Construction, descriptions are given of the types of plants built by the most prominent makers of such plants in Great Britain.

Chapters on the Working and Management, Applications to Practice, and Working Results of suction producers complete this section.

The second section deals with the General Principles and Design, and the Construction, Management and Application to Practice of pressure producers for non-bituminous fuel.

The third section contains descriptions of various types of pressure plants in which bituminous coal is used, both with and without recovery of residuals, deals quite fully with the apparatus employed to cool the gas and to free it from tar, and concludes with a chapter on the Management, Results and Applications to Practice of plants of this type which, owing to the elaborate nature of the cleaning apparatus required, are only used for very large installations.

Two short appendices treat of the physical and chemical properties of coke oven gas and blast furnace gas respectively.

The descriptions of apparatus are clear and well illustrated, and the points to be looked out for in designing different portions of the plant and the influence of these points upon the design are fully explained, as is also the way in which both suction and pressure plants should be handled when being started up from the cold and during normal running. These directions for operation form a distinctively valuable feature of the book.

In telling how plants should be started up, stress is laid upon the precautions which must be taken to prevent the ignition of the explosive mixture of gas and air which will be formed in the cooling and cleaning apparatus while purging it of air by the method described by the author. The formation of such an explosive mixture can be prevented by purging the apparatus of air with the mixture of carbon dioxide and nitrogen which is formed when the blowing up of the fire is first begun. To effect this purging in a suction plant the blow-off cock on the chimney pipe should be closed, and that on the expansion box opened, immediately after the generator is charged with fuel, since the gas made at this time will consist almost entirely of carbon dioxide and nitrogen. When the air has been completely driven out of the apparatus by this mixture the cock on the chimney pipe should be opened and that on the expansion box closed, to relieve the fan of the pressure of the apparatus during the remainder of the time required to bring the generator fire into proper working condition. A similar method of procedure with pressure plants will fill the apparatus, including the holder with inert gas, which can later be purged out with the good gas without forming an explosive mixture.

Interesting features of the book are the report of the results obtained in the competitive trial made at Derby, England, of suction producer plants, the data as to the conditions existing in the cylinder of a gas engine fed from a suction plant when a sudden change is made from no load to full load, and the discussion of the relative advantages of vaporizers of the flash boiler type, which evaporate a definite quantity of water, and those which, by passing the air over the surface of the water, saturate this air at whatever temperature it possesses when it leaves the vaporizer, and of the importance of providing automatic regulation for the amount of water to be evaporated. The author is connected with a firm which manufactures producers built with vaporizers of the flash boiler type without automatic regulation of the amount of water evaporated and naturally believes in the practice of his firm, but he gives very good reasons for this practice.

Those who wish to know why gas producer plants are built as they are, and how they should be operated after they are built will find this book a valuable addition to their libraries.

HYDRAULIC TABLES AND MEMORANDA.—By H. D. Jerrett, Practical Civil and Hydraulic Engineer. San Francisco, Cal.: Eugene Dietzgen Co. Leather; 3 × 5¼ ins.; pp. 142; 8 illustrations in the text, and 65 tables. $1.50.

There are a number of hydraulic formulas and tables necessary for field practice which are, as a rule, only available in bulky volumes. These have been collected by Mr. Jerrett in this little book, which can really be called a pocketbook, and, allowing for the necessary losses in clearness and amplitude due to lack of space, they should fully serve the purpose for which they are intended.

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A Needed Book on Typhoid and Its Prevention.

TYPHOID FEVER.—Its Causation, Transmission and Prevention. By George C. Whipple, Consulting Engineer. With an Introductory Essay by William T. Sedgwick, Professor of Biology, Massachusetts Institute of Technology. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5¼ × 8 ins.; pp. xxxvi. + 407; folding plates and text illustrations. $3, net; English price, 12s. 6d., net.

Rarely is a book written with such capabilities for good as has this one. There has long been needed a book which would combine enough of medicine, biology, sanitary engineering, vital statistics, economics and common sense to serve as a guide and instructor for all who are enlisted in the campaign against the needless typhoid scourge that causes so much expense, misery and death every year. The need is now so admirably filled that one can only wish that equally satisfactory hand-books could be speedily provided for other communicable diseases.

Two paragraphs from the Preface are worth quoting to show the relations of the physician and the engineer to typhoid fever and also the object and general scope of the book:

The fight against typhoid fever must be made largely by men of two professions, by physicians and engineers. Differences in temperament, in training, and in the nature of their work have prevented these two professions from cooperating as closely as they must if typhoid fever is to be relegated to the class of infrequent diseases. The doctor naturally thinks of men as individuals; he is not accustomed to think of men in masses. The sanitary engineer, with his genius for mathematics and statistics, studies communities at large, and is in danger of neglecting to study the details of particular cases. The two professions admirably supplement each other. The engineer is by training the best fitted to control the measures which are instrumental in warding off the disease, to deal with matters of water supply, sewage disposal, and the other sanitary arts; while the physician is best fitted to attack the disease in the household.

The object of this book is to furnish to the members of these two professions a condensed summary of the most important facts that have been learned regarding typhoid fever, so far as they relate to the prevention and spread of the disease; to furnish to the student of sanitary science a group of illustrations of some of the leading principles of epidemiology; and to give to the general reader a simple and, it is hoped, a clear and correct account of the causation, transmission and prevention of the disease, and his own responsibility in helping to bring about such conditions of cleanliness that typhoid fever shall soon cease to be a national disgrace.

A frontispiece diagram effectively illustrates the means of the transmission of typhoid from the patient to another victim. Circles indicate three barriers against the escape of infectious matter from the typhoid sufferer, on the one hand, while on the other hand circles are used to denote three lines of defense against the entrance of typhoid bacilli to new hosts and possible victims. In each case the responsibilities are grouped, about the public authorities, the household and the individual, and include the duties of doctors, nurses, householders, and boards of health, as regards medical treatment, disinfection, tests and inspections, supervision of food, milk and water supplies, sewage disposal and water purification.

The diagrams serve to outline in some detail the scope of the book, but in addition to the topics indicated there are chapters on the bacteriology of typhoid fever, statistics, epidemics and the financial aspect. A hundred pages of appendixes deal with disinfectants, house flies, estimating population, corrected death rates, tests for typhoid and the literature of the subject. Numerous useful and heretofore scattered statistics are given in final appendix.

It is to be hoped that the book will have a wide circulation and careful reading and heeding among engineers, physicians and lay-members of boards of health, as well as many others who are interested in the public wealth and health.

THE STRENGTH OF CHAIN LINKS.—By G. A. Goodenough and L. E. Moore. Bulletin No. 18, University of Illinois Engineering Experiment Station. Urbana, Ill.: The University. Paper; 6¼ × 9 ins.; pp. 73; 37 illustrations in the text and 18 tables.

The limited amount of experimental tests on the strength of chain links and the incompatibility of the accepted theories as to such strength with the results in actual practice led Professors Goodenough and Moore to attempt to reconcile theory and experiment or rather to adjust the present theory in accordance with the behavior observed in numerous test pieces. These tests were made at the University of Illinois, under the direction of Prof. Moore, covering a period of several years, and are reported in the present bulletin, in addition to a mathematical treatment of the theory of chain links, prepared by Prof. Goodenough. The formulas finally derived from the tests do not differ largely from those at present accepted, but are more valuable than the former on account of their sound experimental foundation.

Corporation Accounting.

Reviewed by FREDERICK A. CLEVELAND.*

CORPORATE FINANCE AND ACCOUNTING.—Treating of the Corporate Finances and Securities; the Corporate Books of Account; Reports; Negotiable Instruments; and the Powers, Duties and Relations of the Corporation Treasurer. With Forms. By Harry C. Bentley, C. P. A. Legal Notes by Thomas Conyngton, of the New York Bar. New York: The Ronald Press. Cloth; 6 × 9½ ins.; pp. 525. $4.

SIMPLE MINE ACCOUNTING.—By David Wallace, Expert Mine Accountant. New York: Hill Publishing Co. Cloth; 6 × 9¼ ins.; pp. 63. $1.

The first-mentioned volume is obviously a book intended for an inexperienced treasurer or bookkeeper of a relatively small corporation or as a text for an elementary school. In its six parts the author has brought together a little corporation law, a few extracts from corporate charters, a little corporation finance, a little accounting and a little commercial law, and has had the law subjects annotated by a lawyer. In the selection of materials judgment has been used to give to the uninformed a complement of ideas that may be useful, but in no part is the work systematic. This is necessarily the case when an encyclopedic range is claimed for a single volume production. An impossible task has been set by the author—that of describing in detail methods of corporation accounting within a few pages. If anything systematic is to be done in accounting details quite as much must be written about the accounts of each general type of corporation as has been given here to the combined subject of law, finance and accountancy. The book possesses considerable pedagogical value for a school offering a ten weeks' course in business practice, but has contributed nothing to scientific literature.

The author of the second-named work has correctly named his book. It is simple, but so far as it goes is systematic. It would be of little or no service to one who had had experience in mine accounting. It is too elementary for an extensive mining operation. But it is sound in principle. In reading the book one carries with him the picture of the "young graduate who understands surveying and assaying" introduced by the author as having been sent by a new company to old Mexico to take charge of the development of a new property. To such an one the book would be useful.

Autogenous Welding.

AUTOGENOUS WELDING OF METALS.—Translated from Reports of the National School of Arts and Trades of France, by L. L. Bernier, M. E. New York: The Boiler Maker (17 Battery Place). Paper; 4½ × 6½ ins.; pp. 45; 32 illustrations in the text. $1.

At the beginning this book creates an unfavorable impression. This trouble seems to be a confusion between the terms "autogenous" and "oxyacetylene." For instance, there are the following passages:

The so-called oxyacetylene welding of metals consists in the assembling, by means of more or less complete melting of metallic pieces of the same nature, the surfaces of which are brought in contact at a high temperature without interposition of a different metal from that constituting the pieces.

By extension, the name "oxyacetylene" has been applied to welding made between pieces of different metals which can, however, form a resisting alloy. . . . . if we were to refer to the definitions of oxyacetylene welding we would have to establish the following classification:

Welding with a blacksmith's forge.
Hydro thermal welding.
Electrical welding.
Oxyhydric blow-pipe.
Oxyactylenic blow-pipe.
Illuminating gas and oxygen blow-pipe.

These definitions are obviously too broad to cover merely oxyacetylene welding, and it must be inferred that a translator's mistake has resulted in the use of that term instead of "autogenous." The error, fortunately, does not extend beyond the first two pages of the book.

The remainder of the first chapter is a comparison of various ways of getting high temperatures in small areas for light industrial processes. Chapter II. contains descriptions of various oxyacetylene welding apparatus, and the final chapter (III.) gives methods of using the oxyacetylene blow pipe and shows comparative costs of repair work done by various shop methods.

There is much useful matter in the pamphlet, but it is all on European practice. No mention is made of American apparatus and methods. In view of this fact and the size of the pamphlet the price seems far beyond reasonable bounds.

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Reviewed by S. J. ZOWSKI.*

BAU RATIONELLER FRANCISTURBINEN-LAUFRAEDER.—Und deren Schaufelformen für Schnell, Normal—und Langsam-Läufer. By Viktor Kaplan. Munich and Berlin, Germany: R. Oldenbourg. Cloth; 5½ × 8⅜ ins.; pp. 346; 91 illustrations in the text and 7 plates. 9 marks; American price, $3.60.

The European water turbines were not built by the "cut-and-dry" method of procedure; they were calculated and designed by engineers, trained in theory, and, when built, gave the expected results. Science and practice went hand in hand. For the solution of the modern radial inward-flow turbine problem the classic turbine theories were not sufficient. Some new, special investigations had to be made. The conditions of flow through the runner had to be analysed. Methods had to be invented for "laying out" runners, which would secure the desired flow. The literature on this subject is very rare and of quite recent date. Mr. Kaplan, in the book before us, is the first one who attempts to give justice to the entire runner problem.

According to the general practice in classifying the radial inward-flow runners, so-called Francis runners, Mr. Kaplan distinguishes low, medium and high-speed runner types, subdividing the latter into high and low-capacity types. Each of these four types has some characteristic features and offers other difficulties in design. Naturally, then, after a discussion of general principles, the author considers each type separately, points out its characteristics and difficulties and gives methods of overcoming these difficulties in calculation and design. Each type is illustrated by a numerical example worked out in detail. That the construction methods of Speidel-Wagenbach and those of Victor Gelpke have been explained will be appreciated by the turbine designers; also the valuable collection of half-tones showing the various runner types built by the leading turbine manufacturers in Europe.

In the first part of the book the author recalls some of the principal hydraulic relations and derives some new ones. The derivation of the formula for the guide-vane angle is very interesting; it shows again how differently the turbine problems can be attacked and how the various turbine proportions affect each other. But since the problem always will be: to design a turbine for a given head, power and speed and for technical reasons (standardization) one will decide for a certain bucket angle, the guide-vane angle will be given by the speed diagram, after the runner diameter has been determined or chosen. What remains to be figured is the entrance height. As regards the limiting values for the ratio of entrance height to runner diameter, the upper value, ½, as given by the author, represents good practice, but the lower value, 1/14, has been exceeded considerably. There are turbines, built by the Allis-Chalmers Co., of Milwaukee, Wis., which work quite satisfactorily with entrance heights as small as 1/30 of the runner diameter.

Since the runner bucket is a curved surface enveloping the water-flow lines, the author proceeds to analyze these lines, which must be smooth curves, giving at the entrance and discharge the proper angles. To ensure a smooth flow the water-flow lines should be also equidistant, at least for a certain distance from the discharge edge. The last condition is fulfilled by the isogonal trajectories. Hence these curves are analyzed on the cylindrical, conical and ring surfaces, which are formed by the rotating water-flow lines, and three methods are indicated of an approximate design of the same in plan view and elevation. The third method gives curves which practically coincide with the theoretical isogonal trajectory. Finally, giving methods of designing any flow line on cylindrical, conical and ring surfaces in plan view and elevation he solves the problem of laying out the runner. The final technical layout is merely a topographical drawing of the surface determined by the drawn water-flow lines.

Going over to the different runner types, Mr. Kaplan derives a type characteristic,

$$N_o = N \frac{\sqrt{Q}}{\sqrt[4]{H^3}}$$

which he calls the "unit speed," and which for the different types will have different values. It would have been better, however, to adopt that type characteristic, which is known in Germany under the name "specific speed"

$$N_s = \frac{n\sqrt{H.P.}}{H\sqrt[4]{H}}$$

Both characteristics are practically identical, the only difference being that the capacity is expressed in the first formula by the discharge Q, in the second by the power $H.P.$ But the author is mistaken in claiming that his type characteristic is more convenient "because it does not involve the efficiency which one must assume to figure $H.P.$" Quite the contrary: for when a turbine is to be built the power is always given and the discharge must be figured on the assumption of the efficiency; for an existing turbine it is much easier to find the power than the discharge.

To figure the limiting values of this "unit speed" for the four runner types, the author expresses the runner diameter in parts of the draft-tube diameter and the latter by the discharge and draft-tube speed. This procedure is not permissible for high-capacity runners, because the capacity of such runners is limited by their *least passage areas*, not by their draft-tube sizes and draft-tube speeds. Is what is called "overgating" unknown to the author, or how does he otherwise explain it? For this reason the values which he figures for the high-capacity runners are far beyond practical limits.

Because the importance of the least passage area for high-capacity runners is overlooked, the modern American runners are not properly appreciated by the author. All modern American runners show clearly the tendency to increase this critical area as much as possible. The entrance edge of the bucket has been inclined and the outer rim of the runner has been carried out for that very reason.

The American high-capacity runners deserved more and more careful consideration. What the author says about them is not sufficient and needs some corrections. Neither the Trump nor the Success runners are the leading high-speed and high-capacity runners. Taking one of the above-mentioned type characteristics as basis, the Trump runner occupies the eighth place and the Samson runner the fourth place among the American standard runners. To say that the curvature and water guidance of the Trump runner are the "worst possible" and to show only one section through the runner is not sufficient. The turn into the downward direction is not so dangerous as the author states. This would become apparent if the guide case had not been omitted in the sketch. The turn is made by the water stream, before it enters the runner. This is a general characteristic of the American runners and an advantage which the author overlooks, because, as mentioned before, he does not appreciate the importance of the least-passage area.

Writing about the different practice in laying the discharge edge of the bucket, the author deems it sufficient to make only a statement in a footnote that it is entirely wrong to make this edge a straight line in the horizontal projection. In view of the fact that the most prominent turbine builders and designers in Europe and all experienced turbine builders in America design and build their runners with a straight, mostly radial, discharge edge, this matter deserved a few more words and arguments—were it only to mention some technical advantages of the straight edge. Purely technical considerations are frequently more important for the final decision of the designer than the most elaborate theories and calculations. Such considerations should not be omitted in a book on the design of *rational* runners.

In spite of these deficiencies, the book, as a whole, is a valuable addition to the literature on water turbines. How much work is stored in the

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346 pages which the book contains, both in text and drawings, only those can appreciate properly who themselves have had occasion to calculate and lay out runners. And the author can certainly expect that every turbine designer and many other engineers who are interested in water turbines will read his book with pleasure and satisfaction.

Chemical Equilibrium in the Combustion of Gases.

Reviewed by LIONEL S. MARKS.*

THERMODYNAMICS OF TECHNICAL GAS-REACTIONS.—Seven Lectures. By Dr. F. Haber, O. Professor at the Technische Hochschule, Carlsruhe. Translated by Arthur B. Lamb, Director of the Havemeyer Chemical Laboratory, New York University, New York City. London, New York and Bombay: Longmans, Green & Co. Cloth; 5¾ × 9 ins.; pp. 356; 20 illustrations in the text. $3, net.

The seven lectures by Professor Haber, of which this book is an amplification, have attracted a marked and increasing attention in Germany during the past two years. The matter contained in them is not of applicable value to the engineer or technician, but it is a suggestive contribution in the realm of physical chemistry. The lectures assume considerable familiarity with that subject and also with the elements of thermodynamics.

The object of the book is to present a clear statement of the thermodynamic results of gas reactions in general and in particular of those reactions which are of technical importance. The most important of the gas reactions considered are those between carbon monoxide and oxygen, between hydrogen and oxygen, between carbon monoxide and steam and between nitrogen and oxygen. It is only at high temperatures that the reactions of these gases possess any practical interest and consequently the whole discussion refers principally to phenomena at high temperatures.

At low temperatures, gases generally react upon one another sluggishly, the velocity of reaction increasing rapidly with rise of temperature. This velocity of reaction, which is very important in internal combustion motor work because it determines the rate of propagation of explosion, is not, however, to be predicted by thermodynamic considerations and it is not dealt with in these lectures. An explosive reaction which has once started in a gas will seldom if ever go on to completion; that is, until the whole of the reacting gases have combined and nothing remains but the products of the reaction. This incompleteness often becomes perceptible only at high temperatures when dissociative phenomena manifest themselves most plainly. The reaction tends to go on till a condition of equilibrium is reached, at which the combining and dissociating rates exactly balance each other, and the condition of equilibrium depends on the composition of the reacting gases and on the temperature. It is possible by theoretical treatment to determine the equilibrium condition, and that is the main object of this work. It is all the more valuable because nearly all investigations on the thermodynamics of gas reactions concern themselves with the amount of heat evolved (or absorbed) during the reaction, leaving untouched the question as to whether the reaction goes on to completion or whether it finds an intermediate equilibrium condition.

That the relation of the masses of the reacting substances is one of the most important factors in determining the equilibrium phenomena at any temperature has long been known; but the influence exerted by the specific heats of the substances (and the variations of specific heats with temperature) has not been generally recognized. Such knowledge of the variations of specific heats with temperature is, indeed, fundamentally necessary for the determination of the equilibrium conditions. As the author observes:

> Only when we consider the joint effect of mass action and the specific heats of the reacting substances are we able, from observations made at any one temperature, to draw inferences regarding the phenomena which will take place at a temperature, say a thousand degrees higher. The theory even affords us the expectation of being able to find out all about a gas equilibrium at high temperatures, simply from a knowledge of the heat factors concerned without any experimental determination of mass actions.

The book contains the results of all the noteworthy investigations of the dissociation of carbon dioxide, steam and other gases; of their specific heats and the influence of temperature and pressure thereon; of the rates of reaction of various gaseous mixtures; of the diffusion of gases; of the composition of equilibrium mixtures at various temperatures; and other phenomena. There is some attempt to apply the calculated and experimental equilibrium data to such technical processes as the combustion of coal, and water-gas manufacture. The whole work is suggestive, illuminating and unique, and should prove most valuable to those who desire to study certain of the phenomena observable during the explosion of gaseous mixtures.

The work of the translator has been done most satisfactorily. The changes necessitated by the progress of the subject during the years 1905 and 1906 have either been incorporated in the text or else added as appendices.

*Assistant Professor of Mechanical Engineering, Harvard University, Cambridge, Mass.

Engineering Index.

THE ENGINEERING INDEX ANNUAL FOR 1907.—Compiled from the Engineering Index, published monthly in "The Engineering Magazine" during 1907. New York and London: The Engineering Magazine. Cloth; 6¼ × 9½ ins.; pp. 435. $2.

In accordance with the scheme instituted last year the current Engineering Index is issued as an annual volume, with the articles alphabetically arranged by subjects under the main subheads of the various branches of the profession, instead of the five-year volume with a general alphabetical subject arrangement. Although this restricted classified system may be thought too involved for a large literary catalog, the purpose of which is to locate books, in a current literature index it will be found generally to be the most valuable of any of the systems of classification, principally because it locates in one place all the material on kindred subjects which by purely alphabetical arrangement might be in widely separated parts of the book. The standing of the Index is too well established to need any complimentary comment other than to note that the present volume is fully up to the excellent standard of those previously published.

DIRECTORY OF PORTLAND CEMENT MANUFACTURERS OF THE UNITED STATES.—Corrected to May 15, 1908. Compiled and Published by C. Earle E. Bottomley, Rothschild Building, Philadelphia, Pa. Flexible leather; 3 × 5 ins.; pp. 120. $1.

The second and latest edition of this useful little directory is much more complete and valuable than the 1907 edition, which we reviewed in our issue of Oct. 17, 1907, p. 425. It contains alphabetically arranged in separate lists, the cement companies in this country now operating or able to operate, the companies now constructing plants, the companies now being organized, the officers of the operating companies and finally, an improvement over last year, a list of the various brands of cement on the market and their makers. Descriptive information is furnished under each item.

A TREATISE ON THE PRINCIPLES AND PRACTICE OF HARBOR ENGINEERING.—By Brysson Cunningham, Author of "Dock Engineering," etc. London, England: Charles Griffin & Co., Ltd. Philadelphia, Pa.: J. B. Lippincott Co. Cloth; 6¼ × 9¼ ins.; pp. 283; 248 illustrations, mostly in the text. $5, net.

In our issue of July 14, 1904, p. 46, we reviewed a previous work by Mr. Cunningham on "Dock Engineering" with which the new book on "Harbor Engineering," makes a supplementary volume the two covering the larger portion of the civil engineering side of marine work. Necessarily some of the matter in the two books overlaps, and there is much that is identical, but on the whole the author has displayed admirable care in his selection and has duplicated only when necessary to preserve the unity of the composition.

The book on "Harbor Engineering" is introduced by an historical chapter tracing the growth of navigation with its necessary concomitant, the harbor, and citing as examples the political and physical administration of the early harbors of the world. The second chapter is devoted to harbor design and the effect upon such design of the configuration of the land, the tides and winds and the climatic conditions of the place. The next six chapters take up the methods and materials of harbor construction; surveying, the use of piling, the kinds and qualities of stone and concrete, the designs and construction of breakwaters, piers and quays and of entrance channels. Finally a chapter is given to channel demarcation, signals and lighthouses. Throughout the book the author makes frequent reference to established work, largely from his own experience in English waters, though foreign harbors receive considerable attention, and this free use of examples adds considerably to the worth of the book.

Owing to the constitutionally vested power of the United States government to control all navigable river and harbor improvement, the practice in the larger problems of harbor engineering in this country is limited to the officers of the army engineer corps and their civilian assistants, a very small proportion of the engineering profession. For that reason the principles of harbor design and construction, one of the most important and certainly one of the oldest branches of engineering, is confined here to the few, to whom this book will be of great interest. To the profession in general the discussion of the behavior of structural materials in and about sea-water will be the most valuable part of the book. In particular the study of the effect of sea-water on concrete is worthy of separate publication.

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Reports on the New Croton Aqueduct, Reservoirs and Dams, 1895 to 1907.

REPORTS ON THE NEW CROTON AQUEDUCT, RESERVOIRS AND DAMS, 1895 TO 1907.—By the President, John F. Cowan. Containing Reports of the Secretary, Harry W. Walker, and of the Chief Engineer, Walter H. Sears. New York: Aqueduct Commissioners, Stewart Building, New York City. Cloth; 10¾ × 14 ins.; pp. 139; numerous folding and other tables and 148 plates.

The City of New York has expended on its water supply from the Croton River from the time the so-called New Croton Aqueduct was undertaken, in 1883, to the end of 1906, the sum of $58,184,000. Of this amount about $30,000,000 was spent during the first ten years, chiefly on the construction of the aqueduct itself, a tunnel some 40 miles in length. The report before us records the work done under direction of the Aqueduct Commission for the 12 years beginning with 1895 and ending Dec. 30, 1906. During that time the Commission has built the New Croton Dam at a cost of nearly seven million dollars, the Jerome Park Reservoir at a cost of about six million dollars, and a number of dams in the Croton drainage basin to increase the amount of storage.

No official report has been made by the Commission since Dec. 31, 1894, and the volume before us, therefore is the formal record of a dozen years of engineering construction involving structures of great magnitude. More than half the thickness of the ponderous volume (it weighs 12 lbs.) is taken up in the lithograph reproductions of the working drawings used in bulding the various structures and in half-tone reproductions of photographs showing the progress of the work. Much space is occupied, too, with tables of bids received on various contracts—which are of comparatively small value for permanent reference; and records of the rainfall and run-off in various parts of the Croton basin, which are of very great value.

There is also a reproduction of the mathematical investigations on which the original designs for the Croton dam were based, and the story of the extended controversy and the designs for this dam and its location is told with considerable fulness. In view of the great number of high dams now existing in this country, it is of interest to recall that when the New Croton Dam was first projected in 1883, no high masonry dam had been built in this country. Engineers were compelled to rely on the precedents established by the masonry dams built in France and Spain for their guidance, and the late E. S. Chesbrough was sent to Europe by the city to examine and report on the principal high dams there.

Some of our readers may recall the hot controversy that was waged over the relative merits of straight and curved dams when the Quaker Bridge Dam was projected. A board of experts reported in favor of a dam curved in plan for the Quaker Bridge site, but when the dam was finally built on the Cornell site the straight plan was adopted.

Again in the original designs (which were afterwards substantially carried out) no allowance was made for ice-pressure against the top of the dam. The Board of Experts, in their design, assumed a possible ice-pressure of 43,000 lbs. per lineal foot, and increased the thickness of the dam at the upper part to provide for this. They also battered the dam at the top so that if an ice thrust occurred the ice would slide up the inclined face before it could exert great pressure.

The importance of the work covered by this report and the value especially of the rainfall and run-off data which it contains are such that copies should be secured by every engineering reference library. Much credit is due to Mr. Edward Wegmann, Division Engineer, on whom the chief responsibility for the preparation of the report was placed, for the care and completeness with which the data are presented.

A German Work on Sewage Clarification.

Reviewed by GEORGE W. FULLER,* M. Am. Soc. C. E.

GRUNDZUEGE DER MECHANISCHEN ABWAESSERKLAERUNG.—By Rudolf Schmeitzner. (Fortschritte der Ingenieurwissenschaften, Second Series, Part 16.) Leipzig, Germany: Wilhelm Engelmann. Paper; 7¼ × 11 ins.; pp. 64; 2 plates and 37 text illustrations. 2.4 marks; American price, 96 cts.

This work is the outcome of an inspection trip by the author to some 15 different clarification plants in Germany of various ages and styles of arrangement, of a study of recent literature and of inquiries addressed to various workers in this class of municipal undertakings. The author clearly states at the outset that, while sewage treatment may be divided into sewage clarification and sewage purification, this work deals solely with clarification. No discussion is given of sewage purification and that subject is dismissed with a reference to the reports of recent investigations from the Royal Testing Station at Berlin and to the book on sewage purification published last year by Prof. Dr. Dunbar, of Hamburg.

An introduction of about nine pages sets forth quite clearly the essential features of clarification plants, showing their purpose, not only for eliminating objectionable suspended matter, but also as a preparatory treatment for filtration and for the retention of sewage in connection with the application of a germicide, which usually is chloride of lime according to German practice.

The composition of sewage from the standpoint of clarification is briefly but clearly set forth, preparatory to a logically arranged set of descriptions of various devices in practice for removing those matters which will either float or subside.

Some 50 pages containing 37 figures and two inset sheets, are devoted to a description of German practice in sewage clarification. There are apparently no new devices or arrangements of importance to be found in these pages, and their value consists largely in a convenient arrangement of the practice at various cities grouped in a way to permit of ready comparison of different designs, particularly the more recent ones. Brief mention is made of a few proprietary arrangements for removal of fats and for the mixing of sludge with a product which facilitates the burning of the sludge under boilers.

Unquestionably American engineers engaged in sewage disposal practice can learn much of interest from European practice as regards preparatory treatment and with especial reference to the use of self-cleansing screens for the removal of the coarser suspended solids and the use of settling basins having bottoms with comparatively steep slopes and used in conjunction with devices for the speedy and economical removal of sludge. From these two viewpoints this book should prove of interest to American readers, to say nothing of the record which it contains of the velocities, dimensions and capacities of the more important sedimentation basin now in use in Germany. It is interesting to note that practically nothing is said about the so-called septic treatment.

A PRIMER OF WOOD PRESERVATION.—By W. F. Sherfesee, Forest Assistant. Circular 139, Forest Service, United States Department of Agriculture, Gifford Pinchot, Forester. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9¼ ins.; pp. 15.

This circular explains the causes of decay in timber and the means by which such decay may be retarded. Reasons expressed in the convincing form of dollars and cents are presented, showing that the benefits of wood-preservation are not limited to the conservation of a structural supply for future generations, but save money to the user to-day.

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The Electric Furnace.

Reviewed by FRANCIS A. J. FITZ GERALD.*

THE ELECTRIC FURNACE.—Its Evolution, Theory and Practice. By Alfred Stansfield, D. Sc. Associate of the Royal School of Mines, Professor of Metallurgy in McGill University, Montreal. Toronto, Can.: The Canadian Engineer. New York and London: Hill Publishing Co. Cloth; 5¾ × 9¼ ins.; pp. 211; 52 text illustrations, 1 plate and 14 tables. $2.

Dr. Stansfield's remark that his book is an endeavor "to present as simply as possible, the principles on which the construction and use of the electric furnace depend and to give an account of its history and development" gives a more accurate notion of its scope than does its somewhat ambitious title. No one to-day is competent to write a book which might fitly bear the title of Dr. Stansfield's work. The rapid proliferation of electric furnace design makes a study of its evolution a very difficult matter. Deductively we may consider certain broad principles as regards its theory, but anything like a theoretical consideration based on the inductive method is at present impossible. Finally, electric furnace practice is so specialized at present that no single person is able to inform us as to the details of the various apparatus included under the general term electric furnace. Héroult, Acheson and Colby might discourse profitably on electrode furnaces, those of the carbon resistor type and the induction furnace, respectively, but probably none of these inventors, nor many others who might be named, could write a book on the electric furnace such as a Thompson on "Dynamo Electric Machinery" or a Fleming on "Alternate Current Transformers."

Books on electric furnace work may be divided into two classes: those presenting work done by the authors in certain special fields, and those consisting of a representation of the work of others, originally presented in the form of papers read at scientific meetings, or contributed to technical journals. Dr. Stansfield's book belongs to the latter class; and he wisely refrains from attempting to describe all forms of the electric furnace, but rather chooses certain designs which may be considered typical. The book is brought as well up to date as is possible in the case of a subject undergoing such rapid development as the electric furnace. There is a good index and numerous foot-note references to original articles.

THE ARCHITECTS' AND BUILDERS' POCKET-BOOK. —A Handbook for Architects, Structural Engineers, Builders, and Draftsmen. By Frank E. Kidder, Ph. D., Author of "Building Construction and Superintendence." Fifteenth Edition, revised. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Leather; 4 × 7 ins.; pp. 1,661; numerous illustrations in the text. $5.

A professional handbook, to keep up with the progress of the special line of activity which it represents, must be frequently revised and re-edited, for although the main portion of the matter presented has a perpetual value, many details of practice are subject to the growth constantly going on in the technical world. That this revising process has been followed admirably in Kidder's well-known handbook is evidenced by the publication of this, the fifteenth edition, since the first edition of 1884. It is probable that most of these editions showed but little change, but the last, the fourteenth, published in 1904 and reviewed in Eng. News, Nov. 17, 1904, p. 460, was quite generally revised by Mr. Kidder some time before his death in October, 1904. The fifteenth edition corrects many of the minor errors noticed in the former editions and adds two new chapters by Mr. Rudolph P. Miller, M. Am. Soc. C. E., recently Chief Engineer of the Department of Buildings of New York City, upon "Fireproofing of Buildings" and "Reinforced Concrete." The former of these two chapters is largely rewritten from the previous editions, but the latter is entirely new and supplies a much-needed want in the handbook.

Although Kidder's handbook has long ago passed beyond the limits of its titular "Pocket Book," it is a necessity in all engineering and architectural offices, particularly in those supervising or designing any building work.

*Of Fitz Gerald & Bennie Laboratories, Jewett Block, Falls St., Niagara Falls, N. Y.

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8vo, viii + 317 pages, 11 plates and 130 figures. Cloth, $3.00.

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REPORT ON FIRE JAN. 10, 1908, IN PARKER BUILDING.—Southeast Corner 19th St. and Fourth Ave., New York City. (By W. C. Robinson, Chief Engineer of the Underwriters' Laboratories (Chicago) of the National Board of Fire Underwriters.) New York: New York Board of Fire Underwriters (C. F. Shallcross, Chairman Building Code Revision Committee). Paper; 5½ × 8¾ ins.; pp. 24; 31 plates.

In the burning of the 12-story and basement Parker Building in New York City last January the profession had the first opportunity to note the effect of an inside-developed destructive fire on the steel-frame, tile-protected, so-called fireproof building. The destruction was so complete that, for a time at least, serious doubt was cast on the capability of our modern buildings to resist fire, but this report by the experts of the New York Board of Fire Underwriters shows that the vulnerability of the Parker Building is not indicative of what we may expect from all other steel-frame structures, because it was lacking in many of the most necessary fire-protecting precautions which are or should be in the best type of such buildings. The account of these omissions and the recommendations for future practice are valuable additions to the literature of structural engineering.

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Cost and Methods of Concrete Construction.

CONCRETE CONSTRUCTION.—Methods and Cost. By Halbert P. Gillette, M. Am. Soc. C. E., M. Am. Inst. M. E., Managing Editor, Engineering-Contracting, and Charles S. Hill, C. E., Associate Editor, Engineering-Contracting. New York and Chicago: The Myron C. Clark Publishing Co. Cloth; 6 × 9¼ ins.; pp. 690; 306 illustrations in the text and 37 tables. $5, net.

It has been emphasized time and again that the construction of concrete, the intimate details that bring about the successful erection of a carefully designed structure, is of far more importance than the design. This follows from the field-made nature of the material which naturally invites a diversity of prescribed conditions of erection, an almost entire absence of that possibility of standardization which marks a shop-made material. That correct design in concrete is necessary goes without saying, but the very massiveness of the style of construction and the uncertainty of the field results destroys niceties of design and enforces high safety factors. This has been a recognized fact among concrete workers, whose main efforts are always toward impressing upon their superintendents and inspectors the heavy responsibility that rests upon the man on the job in seeing that the study of the man in the office is not rendered worthless by careless construction. Not only does the safety of the structure depend largely on the erection, but the economic advantage to be derived from concrete construction is quite often a question of method, which is the province of the constructor and which at the same time governs and is governed by the design. The literature of concrete has devoted itself mostly to design, that coming primarily in the study of a new subject, but the need of a book on construction is apparent. The new one noted in the headpiece above is the first comprehensive work of the kind, and as such, should have a large circulation.

In the preface the authors say:

> This book is a treatise on the methods and cost of concrete construction. No attempt has been made to present the subject of cement testing which is already covered by Mr. W. Purves Taylor's excellent book, nor to discuss the physical properties of cements and concretes, as they are discussed by Falk and by Sabin, nor to consider reinforced-concrete design as do Turneaure and Maurer or Buel and Hill, nor to present a general treatise on cements, mortars and concrete construction like that of Reid or Taylor and Thompson. On the contrary, the authors have handled the subject of concrete construction solely from the viewpoint of the builder of concrete structures.

With the above purpose in view the authors have collected, from the technical press and society papers and largely from their own personal investigation, a vast number of examples of concrete work. These are presented in concise form, with the unimportant details removed; there is an attempt to preserve a certain uniformity of treatment so as to permit comparison between similar constructions. In addition to these specific examples the authors have added, in connection with every branch of work, general instructions deduced from observation and formulas for quantity and cost estimates. Probably the scope of the work is best illustrated by a statement of the chapter headings, nearly all of which are prefaced with the words "Methods and cost of." The chapter headings are as follows: Selecting and Preparing Materials for Concrete, Theory and Practice of Proportioning Concrete, Making and Placing Concrete by Hand and by Machine, Depositing Concrete Under Water, Making and Using Rubble and Asphaltic Concrete, Laying Concrete in Freezing Weather, Finishing Concrete Surfaces, Form Construction, Concrete Pile and Pier Construction, Heavy Concrete Work in Fortifications, Locks, Dams, Breakwaters and Piers, Constructing Bridge Piers and Abutments, Constructing Retaining Walls, Constructing Concrete Foundations for Pavement, Lining Tunnels and Subways, Constructing Arch and Girder Bridges, Culvert Construction, Reinforced-Concrete Building Construction, Aqueduct and Sewer Construction, Constructing Reservoirs and Tanks, Constructing Ornamental Work and Waterproofing Concrete Structures.

As would be expected from at least one of the authors a large portion of every page is given up to cost data. In fact, the amount is appalling and at first inspection the reader is quite liable to doubt its utility. This doubt is the natural consequence of a continuous reading in which the object is to gage the value of the book and not to find information on any one particular branch of the concrete question. The necessity of prolonged pages of cost data, in the preparation of which the reader has had no hand and concerning the foundation of which he has no knowledge, is a constantly debated subject. Undoubtedly too much is made of such data by many, but nevertheless there is a certain value, for purposes of estimate and comparison, in well collated cost figures which warrant their publication, and those presented by Messrs. Gillette and Hill will be found to be worthy of reference many times over.

On the whole the book is a welcome addition to concrete literature. It is frankly a compilation and suffers from some of the ordinary faults of a compilation, but the work of compiling has been done with so much more care than is usual in such books and so much original matter has been added that the statistical nature, often the bane of collated material, is largely lost. We believe every concrete designer and constructor should have a copy.

Machine Design.

Reviewed by AMASA TROWBRIDGE,* M. Am. Soc. M. E.

MACHINE DESIGN, CONSTRUCTION AND DRAWING.—A Text-Book for the Use of Young Engineers. By Henry J. Spooner, M. Inst. M. E., Assoc. M. Inst. C. E., Director and Professor of Mechanical and Civil Engineering in the Polytechnic School of Engineering, Regent St., London, Author of "The Elements of Geometrical Drawing," etc. London, New York and Bombay: Longmans, Green & Co., Cloth; 5½ × 8¾ ins.; pp. 691; 5 plates; 1,433 text illustrations and 86 tables. $3.50.

This a book of detail. It consists of 32 chapters treating of practically all the various mechanical details met with in ordinary design. In the first chapter one reads the most complete directions for sharpening a drawing pencil, even to the rubbing of the point on a file. Such extreme detail is not continued throughout the book, however, for the most of it is devoted to matters that are important features in design. The first five chapters are descriptive of drafting-room practice. This is English practice and not at all what is found in modern American offices. The use of tracings and blue-prints is not mentioned, while there is much said about rubbing up india ink, colors, etc. The mixed-up arrangement of views on a drawing commonly practiced in England, and by architects in this country, is also set forth.

The remaining chapters are almost all devoted to machine elements. These are described and, where possible, rules for proportioning them are given. This part of the book is remarkably complete, the various subjects being generally treated analytically beside having numerous illustrations to guide the student. Standards which have been adopted for various materials are given, wherever practicable. Many of the standards given are British and are of use in this country principally for comparison, or for designing machinery for export.

The author uses three methods for impressing on the mind of the student the various facts brought out in a chapter. He gives first some analytical problems to be solved, second some exercises to be correctly drawn to scale, and last, some exercises to be sketched free-hand. This last is a commendable innovation as most young engineers get far too little practice in proportional sketching.

In one respect the book is much better than

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